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SCIENTIFIC FREEDOM *VERSUS* SECRECY

THE importance of full freedom of communication of information has been emphasized, notably by Sir Henry Dale in addresses in Great Britain and also in his Pilgrim Trust lecture delivered in the United States last October; and he returned to that theme in his presidential address at Dundee to the British Association. His pleas, which have been reflected in the recent reviews of the work of the Carnegie Institution of Washington and of the Rockefeller Foundation by the respective presidents of those Institutions, Dr. Vannevar Bush and Dr. Raymond Fosdick, form part of a wider movement towards the restoration of a fundamental human freedom restricted during the War and seriously infringed in several countries during the two decades preceding the outbreak of war. In the definition of human rights and fundamental freedoms which forms Part II of the draft put forward by the United Kingdom representative on the United Nations Commission on Human Rights, as a basis of discussion for an International Bill of Human Rights, Article 14 deals specifically with this question. Every person, it is submitted, "shall be free to express and publish his ideas orally, in writing, in the form of art or otherwise, and shall be free to receive and disseminate information of all kinds, including both facts, critical comments and ideas by books, newspapers, or oral instruction, and by the medium of all lawfully operated devices. These freedoms of speech and information may be subject only to necessary restrictions, penalties or liabilities arising out of considerations of national safety, the inciting to alter by violence the system of government or to promote disorder, crime, or obscenity, or injurious to human rights and fundamental freedoms, justice or the reputations of other persons."

Whatever reservations may well be held as to the practicability of framing definitions which will not be open to abuse, the question is engaging the serious attention of the United Nations. The fundamental provisions of the Bill of Rights relating to freedom of speech and information are to be completed by other agreements resulting from the work of a Sub-Commission on Freedom of Information and of the Press which has also been established by the Economic and Social Council, and which on May 19 began its work of making recommendations regarding the preparation and agenda of an International Conference on Freedom of Information. This Conference is to be called in March or April 1948, and a draft agenda which has already been approved by the Sub-Commission includes seven items. These cover the principles of freedom of information; the gathering of news and information; its transmission; the right of all persons and peoples to receive accurate, objective, comprehensive and representative information; the provision of machinery to promote the free flow of true information; and problems involved in the establishment of information services by Governments or other groups or persons to make information available in countries other than their own.

The fundamental principles which information media should observe in the performance of their functions were listed as four: to tell the truth without prejudice and to spread knowledge without malicious intent; to facilitate the solution of the economic, social and humanitarian problems of the world as a whole through the free interchange of information bearing on such problems; to help promote respect for human rights and fundamental freedoms for all, without distinction as to race, sex, language or religion; and to help maintain international peace and security through understanding and co-operation between peoples. The Sub-Commission will work in consultation with the United Nations Educational, Scientific and Cultural Organisation, and it is clear that it will be helped in its task not only by what that Organisation is already doing in promoting the provision of scholarships and exchange of personnel, but also by the investigations into the freedom of the Press which are already proceeding elsewhere. The Royal Commission to inquire into tendencies towards monopoly in the British newspaper press, set up as a result of a debate in the House of Commons last October, is clearly covering much ground in common with this Sub-Commission. A Commission on Freedom of the Press set up with R. M. Hutchins as chairman to inquire into the position in the United States has already reported, and both its General Report and the special studies still in preparation will make an important contribution to the general discussion.

The General Report of the American Commission* points out that freedom of speech and of the Press is close to the central meaning of all liberty. Where men cannot freely convey their thoughts to one another, no other liberty is secure; and Sir Henry Dale in his Pilgrim Trust lecture emphasized that the right and duty to tell the world the truth which we discover, without regard to the interests of any person, prejudice, creed, political theory, or national policy, has been the central item in the charter of scientific freedom. Secrecy, he urged, is the main infection from which science sickens to-day, and accordingly it is the right and duty of the world's men of science to unite in warning the world of the danger which national policies threaten to the integrity of science by failing to free it from the secrecy accepted as a necessity of war.

There may be difference of opinion as to how far that threat of secrecy is a reality in Great Britain to-day. Prof. C. N. Hinshelwood, in his centenary address to the Chemical Society, welcomed the increasing readiness of chemical industry to publish scientific papers; but he was not, to use his own phrase, 'tilting at a windmill' when he went on to express the hope that the whips of commercial secrecy would not be succeeded by the scorpions of military security. Such misgivings have largely arisen out of the provisions of the Atomic Energy Act, and despite the Government's manifest intention that the new powers shall involve the least possible interference with the freedom of science, as has already been pointed out in these columns (*Nature*, 159, 807; 1946), great care will be required in framing orders for exemption so that genuine discussion is not impeded; the price to be paid for leakage of information may easily be too high. Moreover, even if no exclusion of workers from other countries from the laboratories where nuclear or other 'secret' work is in progress is involved, no one country can be altogether indifferent to the position elsewhere. The new law on disclosure of State secrets published in Moscow on June 11 is a portent which may more than outweigh movements among scientific workers themselves, such as the American Chemical Society's appropriation last year for promoting international understanding and goodwill by enabling foreign chemists and chemical engineers to pursue advanced study in the United States, or the more recent Centenary Fund of the Chemical Society for promoting the international interchange of new chemical knowledge through lectures by distinguished chemists from overseas or participation of its fellows in scientific meetings overseas. The new Russian law classifies, among other subjects, as secret and not to be disclosed under penalties up to twenty years imprisonment, "information constituting State secrets concerning industry as a whole and individual branches of it, agriculture, trade and transport", and "discoveries, inventions, technical improvements, research and experimental work in all branches of science, technology and national economy".

It is not merely that the existence of such a law makes nonsense of any agreement on control of atomic energy through an inspectorate. The discussion on the Atomic Energy Act in Great Britain last year is sufficient to show how dangerous such an outlook is to the very existence of science; and no amount of goodwill to science in other countries can disguise the appearance of an infection and a danger that would have seemed incredible to the international band of men of science a hundred years ago, of whom Prof. John Reed spoke at the centenary meeting of the Chemical Society. Even before the fresh restrictions on newsprint came into force on July 21, the meagre reports in leading newspapers of such important events as the centenary meetings of the Chemical Society and the International Congress of Pure and Applied Chemistry supplied a striking example of the inadequacy of existing supplies of newsprint for meeting the needs of society for the communication of news and ideas. The American Commission on the Freedom of the Press observes in its report that where freedom of expression exists, the germ of a free society is already present and a means at hand for every extension of liberty. Such witness to the importance of full freedom of scientific communication is doubly valuable at this moment. Not only should those in Britain and other free countries unite their efforts to prevent any further extension of the area of secrecy, but also they should follow with the closest attention the debate now proceeding on the question of freedom of communication.

* A Free and Responsible Press. A General Report on Mass Communication: Newspapers, Radio, Motion Pictures, Magazines and Books. By the Commission on Freedom of the Press. Pp. xii+139. (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) 2 dollars.

ULTRAFILTRATION ANALYSIS

Leçons de chimie physique appliquée à la biologie professées au Collège de France

Par Prof. J. Duclaux. 14 : Ultrafiltration, ii. Partie théorique et applications. (Traité de chimie physique, Tome 3, Chapitre 2.) (Actualités scientifiques et industrielles, 1002.) Pp. 126. (Paris : Masson et Cie., 1946.) 140 francs.

ULTRAFILTRATION can prove a most valuable method for the investigation of disperse systems, but, in his treatise on the subject, Dr. Duclaux leaves his readers in no doubt as to its inherent difficulties. In spite of these, however, considerable progress has been made in recent years, attributable largely to the more reproducible and uniform membranes—'Gradocol'—now available, covering an adequate range of graded porosities for the requirements of research workers in bacteriology, pathology, biochemistry and analytical chemistry. Thus far, their application has been restricted mainly to studies on bacteria, viruses and enzymes, for which they were specially evolved. That they have potential value in much wider fields is clear from the numerous references cited.

The first half of the book deals critically with the several methods used to calculate the pore-size of an ultrafilter membrane. Although precise knowledge of the structure of collodion membranes is lacking, many data are available that permit an assessment of their uniformity and reproducibility. In order to derive from such data a figure for the porosity it is necessary to postulate a simplified structure. Dr. Duclaux very rightly emphasizes the disparity between this ideal and the real membrane, but the assumptions underlying the basis of calibration are not wholly without justification. It is a significant fact that 'Gradocol' membranes possess the high specific water content of 0·8–0·9 over a wide range of porosities—2,000 mμ, say, down to the region of 20 mμ. This points to the gradation in porosity being due to a progressive change in the state of aggregation of the nitrocellulose. Eventually some fundamental unit is reached, and further diminution in porosity is the outcome of packing more nitrocellulose per unit volume.

Determination of the permeabilities of membranes, as distinct from their porosities, demands knowledge of the processes of ultrafiltration—the effects of applied pressure, the temperature and concentration of the disperse system, surface adsorption and blocking within the pores of the membrane—and means whereby the factors concerned may be controlled. 'Filtration curves', from which the magnitude of adsorption and blocking under varied conditions can be determined, and 'filtration end-point curves', showing how the maximum relative filtrate concentration varies with membrane porosity, must be established for *conditions found most favourable for filtration*. The latter essential is not properly emphasized. Furthermore, when deducing the character of an unknown disperse system, the complete filtration end-point curve must be considered. The actual end-point porosity enables the size of the smallest elements of a particulate phase to be derived, while the form of the curve will give information regarding degree of homodispersity. The relationship between the porosity at which the relative filtrate concentration first falls significantly below unity and that for which it first becomes zero (that is, the end-point porosity) has been found to be about 2 : 1 for homodisperse systems, whereas for heterodisperse systems and those the particles of which have decided asymmetry of shape the two porosites differ much more widely, and the curve may take a stepwise form. The ratio of particle-size to end-point porosity determined for certain known disperse systems is used to translate end-point porosities into probable particle sizes for unknown suspensions. The value of this conversion factor is found to be less than unity and to vary in different regions of porosity. This result is not wholly incomprehensible when the facts of adsorption, non-isoporosity, and of porosities being calculated on the same uniform basis without allowance for variations in membrane structure are all considered. Again, the filtration end-point for an elongated particle is decided by its width, since the longer axis will tend to be orientated in the direction of fluid flow. This has been amply confirmed experimentally, for example, with spirochætes and tobacco mosaic virus. Dr. Duclaux bases his contradiction of this relationship on the filtrability of nitrocellulose, an unfortunate choice because of its gross polydispersity in solution.

It is in every way desirable that the limitations of an experimental method should be thoroughly appreciated. Unfortunately, in Dr. Duclaux's highly critical treatment there is no apparent attempt to embody the positive value of ultrafiltration in a constructive plan for its intelligent application. The student should also read the earlier publication by P. Grabar (1943), No. 957 in the same series, an excellent contribution to the subject. W. J. ELFORD

DANISH WORK ON *ALTERNARIA* AND *STEMPHYLIUM*

Danish Species of *Alternaria* and *Stemphylium*

Taxonomy, Parasitism, Economical Significance. By Paul Neergaard. (Communication from the Phytopathological Laboratory of J. E. Ohlsens Enke, Copenhagen.) Pp. 560. (Copenhagen : Einar Munksgaard ; London : Oxford University Press, 1945.) 60*s*. net.

IN the preface to this valuable work, the author explains the circumstances which led him to the study of the genera *Alternaria* and *Stemphylium*. As plant pathologist to the seed firm of J. E. Ohlsens Enke, he appears to have enjoyed absolute freedom with regard to research and every facility for carrying it out. Working in collaboration with the seed-testing laboratory of the firm, he was thus provided with a unique opportunity of studying seed-borne fungi, among which *Alternaria* and *Stemphylium* play an important part. Every year he examined several thousand seed lots, made isolations, carried out inoculation experiments, and studied the morphology of the various species. The results of his studies are presented in this monumental work of 560 pages, copiously illustrated and well reproduced.

The author's approach to the problem of these genera was to study the living fungi. Starting with single-spore isolations, he selected from five to ten isolates one fully representative of the species as it occurred on the natural substratum, and so far as possible he isolated each species from several hosts and in many instances at several different times from the same host. He also obtained cultures from the Centraalbureau voor Schimmelcultures, Baarn. His examinations comprised morphological characters,

physiological tests on temperature requirements and sporulation, and pathogenicity tests carried out on ten species of seedlings representative of ten families grown in wide test-tubes containing filter paper and about 10 c.c. water. The rows of test-tubes were placed in racks covering the wall. The main result was recorded twelve days after inoculation, but the incubation period was sometimes extended to eighteen days, five degrees of pathogenicity being recognized. These investigations are recorded in the special part of the volume comprising some 300 pages.

The author classifies the fungi he studied into fifteen species of *Alternaria*, of which six are new, besides two new varieties and two so-called 'formæ speciales', and three species and one variety of *Stemphylium*. It is interesting to note that two of his new species of *Alternaria* were antedated by descriptions by Groves and Skolko in 1944, as the author points out in an 'addition' to the book, a taxonomic corroboration that testifies to the quality of the work. The mass of data he has assembled regarding the various species should be of great value to succeeding workers. Each fungus is studied with a characteristic thoroughness, and although no two workers on this difficult group can be expected to see eye to eye on all points, there is evidently developing a consensus of opinion that is in agreement on the most important aspects. The author accepts *Stemphylium botryosum* as the type of *Stemphylium*, and the division of the genus into *Eustemphylium* and *Pseudostemphylium*. He prefers *Stemphylium* to *Alternaria* for the fungus described by Meier, Drechsler, and Eddy as *A. radicina*, on the ground of the shape of the spores, a view which is in line with the authentic culture of this species preserved at Baarn.

An innovation that is likely to meet with opposition is the proposal to adopt *Alternaria porri* f. sp. *solani* for the well-known potato pathogen *A. solani*. The long-beaked forms of the *A. solani* group comprise a number of closely related species, and the author has done well in sorting some of these into groups. The correct names to apply to these groups can only be ascertained from a study of the type specimens of the early described species, and it may well be that an earlier name than *A. porri*, which dates from 1879, may ultimately be discovered. It seems a pity, therefore, to reject a well-established name like *A. solani* unless one is fairly certain that it will not have to be changed again, and the agreement of forty institutions in the British Isles to adhere to the names given in the "List of Common British Plant Diseases" affords a welcome refuge, for some time at any rate, from a change of this kind. In view of Dr. Neergaard's work, however, the examination of the type specimens of long-beaked species described between 1832 and 1879 now becomes a matter of some urgency. The author also devotes a chapter to setting forth his views on nomenclature. He would have us date mycological nomenclature from the "Species Plantarum" of Linnæus (1793), reject a name transferred to another genus on the basis of wrong material even though the transference is nomenclaturally correct—and this in spite of the contrary decision reached at Amsterdam in 1935—would validate varietal names in nomenclatural priority, and finally decapitalize specific names. The last-named view is becoming more and more widely accepted, but the others will probably meet with considerable resistance.

One of the most useful chapters in the book deals with the diagnostic criteria for species. The survey brings out clearly the variable characters of the species, and it is pleasing to find the author stressing the importance of the form and size of the beak. From his survey of the taxonomy of the group as a whole he divides the genus *Alternaria* into various sections mainly according to the length of the conidial chain and the length of the conidial beak. There is no doubt that the segregation of the genus into sections is the right line of approach in the study of this group, as first pointed out by Elliott; the groups proposed by Dr. Neergaard constitute another step forward in this direction.

It is impossible to discuss all the interesting points raised in the book; but these must suffice to indicate the vigorous and thorough way in which the author has studied these fungi and presented us with a contribution that will no doubt have a lasting influence on the study of the group as a whole.

S. P. Wiltshire

THE CAMERA AND BIRDS

Bird Haunts in Southern England

By G. K. Yeates. Pp. 112+99 plates. (London: Faber and Faber, Ltd., 1947.) 15*s*. net.

Again we have the pleasure of a new book from the pen and camera of Captain G. K. Yeates. He does not pall, his pictures and his observations being alike of much interest. Far from showing any falling off in photographic merit or descriptive quality, this volume may be termed his best effort yet. In it he deals with birds to be met with in southern England, from the bittern and the bearded tit on the Norfolk Broads to the hobby on Salisbury Plain. His account of this beautiful little falcon is of especial interest not only as regards the bird itself but as regards its persecution by egg-collectors. He is doubtful if any but a small percentage of the first clutches escape. He remarks, "I know full well the old arguments, that hobbies, when robbed, regularly 'repeat'; that these second nests are left in peace and allowed to hatch; and that many first nests are not found on the fringes of the Plain. Be it so. Yet can any of them deny that the species would stand a better chance if it were left in peace without having forcibly to delay its breeding season?" If the collecting of eggs serves any scientific or otherwise useful purpose no one will begrudge the eggs, but if that collecting for collecting's sake should endanger interesting and beautiful birds it is, to put it in the least forcible terms, certainly a pity—let those afflicted with the collecting mania turn to postage stamps and cigarette cards.

Our regrets on this subject are enhanced by Captain Yeates' lovely studies of hobbies at home. It is not always easy to take photographs in tall and swaying trees, but he overcame all difficulties and got some excellent results. Plate 18, showing a hobby with full-grown chicks, is a particularly admirable study.

Although tree-top photography has its especial difficulties, the portrayal of the small birds of ditch, reed bed and thicket is not an easy task; yet this book abounds in pictures of buntings, warblers, wagtails, etc., of the highest quality. As a portrait of a small bird, the picture on Plate 66 of a male cirl bunting at the nest is hard to beat, though his marsh, reed and sedge warbler photographs make a fine set. This volume will certainly enhance Captain Yeates' already considerable reputation as a naturalist with a camera, or shall we say an 'ornithological photographer'?

F. Pitt

What is Atomic Energy?

By Dr. K. Mendelssohn. (Sigma Introductions to Science, No. 3.) Pp. 180 + 12 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

HE who writes for the general public about scientific matters has all the responsibility of an interpreter. He must explain facts and theories and opinions to people who may not know the words that are a vital part of the science he describes. He needs the gifts of easy writing and apt analogy, but he must also show the devotion to accuracy that is due not only to his subject but also to his readers, who may be misled by a slip of phrase or printing that the expert would instantly recognize as such. Popular scientific writing is a task not to be undertaken lightly, and should be judged by the highest standards.

On these standards, Dr. K. Mendelssohn's "What is Atomic Energy?" comes near to success; it shows fertility in illustration and analogy, and the ability to make a point clear by a neat sentence or a striking diagram. Dr. Mendelssohn chooses to discuss principles more than experimental methods, and in surveying the changes of energy that can occur in the electronic and nuclear structure of atoms he ranges from diffraction patterns to nebulæ and from the principle of indeterminacy to the theory of the atomic bomb. The text and the diagrams are always interesting and often fascinating. Yet all this scarcely achieves the object of giving "a broad outline of the problems of nuclear energy from the point of view of the physicist"; the average physicist has a more practical and more quantitative point of view than is found in this book. The statement that "a kilowatt-hour can bring 65 kettles to the boil" will shock both physicists and the Ministry of Fuel and Power!

Misprints are rather numerous; these, and the other lapses from accuracy, could easily be corrected in a second printing, and we should then have a very good book on the matters of physical principle that, even if only a part of the story of atomic energy, are a fundamentally important part. P. B. MOON

A Chapter in the Theory of Numbers

An Inaugural Lecture. By Prof. L. J. Mordell. Pp. 31. (Cambridge: At the University Press, 1947.) 1*s*. 6*d*. net.

THIS is a report of the inaugural lecture delivered by Prof. L. J. Mordell, the new occupant of the Sadleirian chair of pure mathematics at Cambridge. It shows his characteristic power of giving a simple account of research work and of awakening interest in problems still unsolved.

Most of the mathematical problems of the seventeenth century now appear to us to be quite elementary and to leave nothing open for further investigation. But this does not apply to questions in the theory of numbers. It is well known that Fermat's last theorem has not yet been proved in the general case, although for nearly three hundred years attempts have been made, and all the evidence seems to point to its truth. Since 1908 the Wolfskehl Prize of 100,000 marks has been waiting to reward a sound proof, but none has yet appeared. However, Prof. Mordell touches only lightly on this theorem, and devotes most of his attention to the Diophantine equation $y^2 = x^3 + k$. Some progress was made by Bachet in 1621. Soon after, Fermat declared that he had discovered "an exceedingly beautiful and subtle method which enables me to solve such questions". What this method was has never been ascertained, and Prof. Mordell believes that Fermat was mistaken in his claims. Much later, in 1738, Euler took up Fermat's challenge. His solution was universally accepted for more than a century, but in time it became clear that the reasoning was unsound. Among later work we note that of Mordell himself in 1912. This paper was much more valuable than anyone realized at the time, as it contained the seeds of a fundamental theorem on the rational points of a cubic curve. Even now the paper offers opportunities for further research. H. T. H. P.

Physical Science in Art and Industry

By Dr. E. G. Richardson. Second edition. Pp. xi + 299 + 7 plates. (London: English Universities Press, Ltd., 1946.) 15*s*. net.

THAT there is little change to notice in the second edition of this valuable book is perhaps an indication of how well it has fulfilled its purpose. Originally produced in the darkest days of the War, it invited attention mainly to the conquests already made by physics in various branches of industry and craftsmanship, with here and there the suggestion of greater things to come. At the moment, it seems that we stand poised, ready for advance rather than experiencing it, but it is just here that Dr. Richardson's skill in explanation is most noteworthy. Locomotion, mining, pottery, archæology, paintings, and the rest, all receive their share of attention, and a description of what physical methods can achieve for them. For clarity, these pages could scarcely be bettered: one hopes that readers will not find practice unduly harder than precept. They may, if they are not very careful. The references might with advantage be extended: they are admittedly little more than minimal, but in some cases they seem scarcely the best finger-post to select. It is difficult to strike the happy mean, but the author might consider their enrichment if, as may be hoped, he is called upon for a third edition. F. IAN G. RAWLINS

Vom Ursprung und von den Grenzen der Freiheit

Eine Deutung des Spiels bei Tier und Mensch. Von Gustav Bally. Pp. 140. (Basel: Benno Schwabe und Co., 1945.) n.p.

IN this book Dr. Bally tries to gain insight into human conduct by comparing it with animal behaviour. He undertakes a re-definition of play and examines its aspects in animals and humans. The investigation starts with a description of instinctive behaviour in animals where he traces the origin of play. He shows how this begins only after a certain relaxation in instinctive drives which is achieved by maternal care and protection. Play continues to be found in older animals only if man provides protection from hunger and the enemy's threat, as in domestic animals. Even adult chimpanzees lose the joy of play. The organisation of human society provides a protection which enables man to retain an interest in play during his whole life. It is demonstrated how this comparative satisfaction of instinctive urges leads to the development of freedom. The problem of freedom is then discussed, and the reasons for its success or failure in human society clarified.

The book is most stimulating and deserves to be widely read, for it tries to explain some of the present-day upheavals in the life of human society from a biological and psychological point of view.

THE ONE MILLION-VOLT ACCELERATING EQUIPMENT OF THE CAVENDISH LABORATORY, CAMBRIDGE

By Dr. W. E. BURCHAM
Cavendish Laboratory, Cambridge

THE technical development of nuclear physics since 1930 has been so rapid that it has been somewhat unusual for a high-voltage transmutation equipment to continue in useful service over a period of ten years. The one million-volt apparatus of the Cavendish Laboratory, however, this year reaches its tenth anniversary, and this article has been written to give an account of the performance of the apparatus throughout this period. Particular interest is attached to this performance, because the one million-volt generator was the first completely engineered equipment bought by the Laboratory for research in nuclear physics; its use for this purpose was also the first application of a Philips high-tension generator to the acceleration of positive ions to an energy of 1 MeV.

The building of the Cavendish High Tension Laboratory in 1936 in order that the work of Cockcroft and Walton on the transmutation of the light elements might be extended has previously been described[1]. It was originally intended to construct the whole of the necessary high-voltage apparatus in the laboratory, and this work had already been started when, as a result of the Austin benefaction, it became possible to purchase a complete high-tension generator from Messrs. Philips of Eindhoven, Holland. The decision to purchase this generator, which is itself fully described in the relevant technical literature[2], was taken by Lord Rutherford, advised by J. D. Cockcroft and M. L. Oliphant, and was a major departure, which has been fully justified, from the Laboratory tradition of home-made apparatus. The Philips generator was installed in the early part of 1937 and experiments commenced in August 1937, since when the equipment has been in almost uninterrupted service. No full technical description of this equipment has ever been published, or is now likely to be, and a summary of its main characteristics will therefore be given here as an introduction to a report on its performance.

The Philips generator was delivered without the associated equipment necessary for the production of an ion beam, and the development of this apparatus was carried out by M. L. Oliphant and P. I. Dee, to whose careful design the successful operation of this part of the set has been largely due. An overall view of the apparatus, which is mounted on the concrete roof of a 'research room' and fills about one third of the High Tension Laboratory, is given in the accompanying illustration. The accelerating tube is built of three glazed porcelain insulators each 4 ft. long and 12 in. internal diameter stacked in a vertical column and separated by steel plates supporting the electrodes; the edges of the plates are protected by aluminium corona shields. The electrodes are 4½ in. diameter steel tubes with their ends rounded to a radius of about ¾ in.; the gap between successive electrodes, across which the voltage is applied, is 2½ in. and is located at the centre of each porcelain insulator. The intermediate electrodes are connected to points on the Philips generator equivalent to one-third and two-thirds of the total voltage by water resistances of 2 megohms. The whole tube is evacuated by four 3-in. laboratory-made oil diffusion pumps with a measured total pumping speed of about 150 litres of air per second at a pressure of 10^{-4} mm. of mercury; this is, of course, very low by present-day standards, but has so far been adequate.

The upper half of the top porcelain cylinder contains the ion source, which is of the type described by Oliphant[3] and which has proved extremely successful; the top corona shield which houses the projecting parts of the ion source, oil cooling leads, levelling screws and gas inlet, is of metallized pâpier-maché. Supplies for the ion source have to be generated at high potential, and a miniature power station is housed within a large plywood electrode at the top of an insulating 'Paxolin' cylinder. The 10-kVA. generator in the electrode is driven by a leather belt from a motor at ground potential and supplies power to a transformer connected in a bridge circuit with four Philips G125 rectifiers and a 0·1 μF condenser. An output of about 30 mA. at 50 kV. is available for running the ion source.

The remaining part of the apparatus is housed in the research room under the generator; the ion beam passes down a steel pipe from the last accelerating gap into a resolving magnet which bends it through 90° before it strikes the target under investigation. A shut-off valve and pressure gauges are provided for convenience in operation; the former is of particular use in target changing.

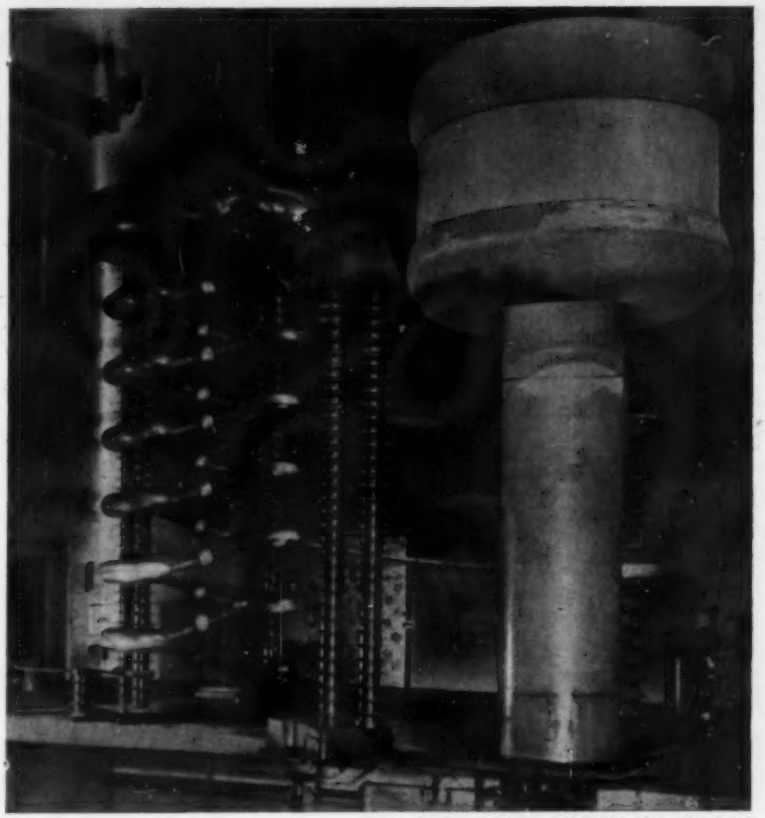
The apparatus provides a magnetically resolved beam of protons or deuterons of 70–100 μA. accelerated by a voltage of 950 kV. or less. The high-tension generator supplies 1,250 kV., which unfortunately cannot be utilized owing to the proximity of the walls of the laboratory. The resolved beam of 70–100 μA., to which corresponds a total unresolved beam of 120–180 μA., is small by comparison with the currents which may be expected as a result of recent developments in ion sources[4], but is limited chiefly by the size of the outlet canal in the ion source, which is in turn determined by the available pumping speed. It is found necessary to maintain a pressure of 0·0003 mm. or less in the accelerating tube to permit steady operation at 950 kV.; the gas consumption is about 3 c.c. of hydrogen or deuterium at atmospheric pressure per minute.

The equipment has maintained this performance without substantial change since 1937, during which time a total running time (high tension in use) of 5,700 hours has been recorded. Complete records of serviceability have been kept since 1942, and from these it appears that faults involving major breakdown have been very infrequent and have rarely consumed more than four or five days at a time, the average time spent on each breakdown being two days. An overall figure of 100 hours running per fault, including all types of major and minor breakdown causing interruption, has been maintained; this is almost certainly much better than would have been obtained with an equipment entirely of laboratory construction, and amply confirms the policy of entrusting as much as possible of this type of installation to the electrical industry. The chief troubles encountered have been (*a*) leaks, which have been probably neither more nor less frequent than with any apparatus of similar age relying largely on

'Apiezon-Q' joints and wax seals; (*b*) enlargement of the ion source canal, which after 1,000 hours running is so much burnt away that the gas consumption increases and the pressure in the accelerating tube becomes too high; (*c*) valve breakdowns, which usually occur at a valve-life of between 1,000 and 2,000 hours. The reliability of the Philips generator and of the Oliphant-type ion source has been the outstanding feature of the equipment.

The first experiment which was attempted with the newly erected equipment in 1937 was a search for the second-order reaction $^2H(^3He,^1H)^4He$, which would be expected to take place in a deuterium target bombarded by an intense beam of deuterons. This was unsuccessful, and it is interesting to note that this reaction has even now not yet been reported in the available literature. There followed some experiments, in logical extension of the work of Cockcroft, Walton and Lewis on the light elements, on the transmutation of fluorine and sodium by protons and deuterons; this type of investigation, carried out with ionization chamber and linear amplifier, has recently been extended to magnesium and aluminium. At the same time, some careful work on proton-capture processes in light elements, leading to the determination of resonance levels and the energy of capture radiation, was carried out; the coincidence-counting technique was applied with success in this field. During the early period while the Cavendish cyclotron was being built, and at later times during its periods of modification, the equipment was used to provide artificially radioactive sources for measurements on β- and γ-ray spectra. The neutron source obtained by using the set to bombard lithium with deuterons is equivalent to 1 kgm. of radium-beryllium; if the equipment is used to provide 6 MeV. γ-rays from the $^{19}F + {}^1H$ reaction, the source strength is about 2 millicuries.

During the Second World War the equipment was devoted, under the supervision of N. Feather and E. Bretscher, to a study of the problem of neutron flux measurement and to the determination of certain nuclear cross-sections required by the atomic energy project. In this field considerable progress was made; the results are only just being published. The one million-volt generator has also been used by C. F. Powell of the University of Bristol in the development of the photographic emulsion technique for the measurement of the energy of charged particles and neutrons, and several experiments on neutron spectra and fission processes have been made in the Laboratory by this method.



By courtesy of Gaumont-British Instructional Ltd.

THE ONE MILLION-VOLT ACCELERATING EQUIPMENT AT THE CAVENDISH LABORATORY

The present and future programme of the equipment has been partly determined by the fact that, since the War, the Laboratory has had to provide for an exceptional number of postgraduate students. During the last two years, fifteen students have used the equipment, and the running time in this period has totalled 2,000 hours; this number of students is rather larger than is convenient. The need for providing a usable beam has moreover prevented the undertaking of any large-scale modifications, and the apparatus has remained essentially a 'general purposes' equipment. As such it has neither the homogeneity of beam required for accurate resonance-level experiments nor the intensity desirable nowadays for a neutron or γ-ray source, and it is likely that in the near future it will develop along one or both of these lines. In the meantime its great merit remains its serviceability; this has been in very great measure due to the unfailing care and attention which it has received from W. Birtwhistle, who has been wholly responsible for the maintenance of the equipment since its erection. It has also been possible at all times to rely on the ready co-operation of Messrs. Philips, whose interest in the generator has continued to be of the greatest value to the Laboratory.

The following short selection of papers gives some idea of the type of work carried on with the 1 MV. set; the work described in them was in whole or part dependent on this apparatus.

Excitation of γ-Radiation in Processes of Proton Capture by Light Elements (Curran, Dee and Petrzilka), *Proc. Roy. Soc.*, A, **169**, 269 (1938).

A Further Study of Nuclear Isomerism (Feather and Dunworth), *Proc. Roy. Soc.*, A, **168**, 566 (1938).

Resonance Phenomena in the Disintegration of Fluorine by Protons (Burcham and Devons), *Proc. Roy. Soc.*, A, **173**, 555 (1939).

Disintegration of Boron by Slow Neutrons (Bower, Bretscher and Gilbert), *Proc. Camb. Phil. Soc.*, **34**, 290 (1938).

Experiments on the Transmutation of Sodium by Deuterons (Murrell and Smith), *Proc. Roy. Soc.*, A, **173**, 410 (1939).

Fission Fragment Tracks in Photographic Plates (Green and Livesey), *Nature*, **158**, 272 (1946).

Short-lived Radioactivity from Lithium Bombarded with Neutrons (Poole and Paul), *Nature*, **158**, 482 (1946).

Upper Limits of Fission Cross-Section of Lead and Bismuth (Broda and Wright), *Nature*, **158**, 872 (1946).

Disintegration of Magnesium and Aluminium by Deuterons (Allan and Clavier), *Nature*, **158**, 832 (1946).

Interaction of Fast Neutrons with Beryllium and Aluminium (Allen, Burcham and Wilkinson), *Nature*, **160**, 473 (1947).

[1] Feather, "Lord Rutherford" (Blackie, 1940), p. 186. Wood, "The Cavendish Laboratory" (Camb. Univ. Press, 1946), p. 57. Cockcroft, "Rutherford", *Proc. Phys. Soc.*, **58**, 625 (1946).

[2] Bouwers and Kuntke, *Z. Tech. Phys.*, **18**, 209 (1937). Heyn and Bouwers, *Philips Tech. Rev.*, **6**, 46 (1941).

[3] Oliphant and Rutherford, *Proc. Roy. Soc.*, A, **141**, 259 (1933).

[4] Thonemann, *Nature*, **158**, 61 (1946).

PULVERIZED FUEL

By T. F. HURLEY, O.B.E.

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THE success of the Conference on Pulverized Fuel held at Harrogate during June 3–6 under the auspices of the Institute of Fuel clearly shows the interest now being taken in this method of firing. Its importance is evident from the accompanying table, which indicates the rapid increase that has taken place in the annual consumption of pulverized coal in Great Britain, particularly by the large electricity undertakings, which, it is estimated, will use 10 million tons per annum by 1950.

CONSUMPTION OF PULVERIZED COAL IN GREAT BRITAIN (THOUSAND TONS)

Year	Steam raising		Process work		Total, all users
	Electricity undertakings	Industrial	Cement and other kilns	Metallurgical furnaces	
1929	714	755	1,244	41	2,754
1939	2,410	1,602	2,222	303	6,537
1946	5,066	1,904	1,975	361	9,306

The smaller increases recorded by other users between 1939 and 1946 may have been due in part to the difficulty of obtaining new machinery during that period.

For most industrial purposes coal is by no means the best fuel; but, even at present prices, it is still the cheapest. It is therefore used, whenever practicable, in all processes in which the cost of fuel is a large proportion of the total cost of the product. Where fuel costs are not an important item, cleaner and more easily controlled fuels, such as gas or oil, will be used.

The advantages of pulverizing coal, that is, grinding it to a fine powder, of which as a rule about 80 per cent will pass through a 200 B.S. sieve, arise fundamentally from the fact that it can then be carried in suspension in a stream of air, thus conferring upon it some of the advantages of liquid or gaseous fuels. It can also be burned in suspension, which makes it particularly suitable for certain metallurgical processes requiring an intense luminous flame, and also for very large boilers, where the use of moving parts exposed to high temperatures is most undesirable. Its principal advantage, however, is that it makes it possible to burn efficiently low-grade small coal which is not otherwise easily disposed of, but which is being produced in ever-increasing quantities under modern mining conditions.

Against these advantages must be offset the considerable cost of providing and running the necessary grinding and other auxiliary equipment, and above all the many extra costs and difficulties arising from the inevitable presence of ash in the fuel.

Ash dominates the whole process of utilizing pulverized coal. In the first place, it represents so much useless material which is transported, at the same price as the coal, from the mine to the user and which is ground with the coal, so reducing the output of the mill and causing most of the wear and tear in the system. Secondly, it influences combustion chamber design more than does the process of combustion itself; and finally, after the useful fuel has been burned, the ash has to be collected with difficulty from the flue gases and, after collection, disposed of with equal difficulty. It is no exaggeration to say that the whole history of the development of pulverized fuel firing is that of a struggle for the mastery of ash.

In 1946 the percentage of ash in most of the coal pulverized at power stations and in cement mills in Great Britain was between 14 and 18 per cent. About three quarters of it could have been removed by known cleaning processes. Why then was the coal not cleaned at the collieries, thus eliminating some of the troubles just mentioned? The immediate answer is that sufficient coal-cleaning plant is not at present available. Should it become available in the future the answer will depend upon economics, taking into account the price structure at that time. It must be borne in mind that to clean very fine coals it is necessary to wet them, and this involves adding the cost of drying to that of pulverizing. In any event, no cleaning process removes the inherent ash, and this would still have to be dealt with by the user.

Pulverized fuel firing was first used on a large scale in the cement industry in the United States so long ago as 1894, when it was applied to large rotary kilns. Its success was due to the fact that the kilns provided a combustion chamber of the ideal shape and size for burning poorly prepared fuel, with a burner of elementary design. The ash problem did not arise; indeed, the ash was sold as part of the product.

Other applications lagged far behind and were hindered partly by a general lack of knowledge, but mainly because pulverized fuel was regarded solely as a means of utilizing very dirty slack coal. Progress, however, has been such that reliable commercial apparatus is now available which will enable pulverized fuel to be burned efficiently in plant ranging in size from the small metallurgical furnace and the Lancashire boiler to the modern power station boiler which evaporates hundreds of thousands of pounds of steam per hour. Technical development is now directed towards the simplification of plant and its operation, and to the reduction of capital and running costs.

The trend towards simplicity may be illustrated by the fact that the bin-and-feeder system has been largely displaced by the unit system. At one time the processes of drying and grinding were carried out in separate apparatus, and the ground coal was delivered to a storage bin which smoothed out inequalities of supply and demand. The coal was extracted from the bin by feeders and carried to the burner by an air supply the quantity of which was determined by combustion conditions. With the modern unit system there is no reserve between the mill and the burner. The feed is controlled at the entrance to the mill, in which the coal is not only ground but also dried by means of hot air, possibly supplemented by hot gases drawn from the combustion chamber. The same air carries the pulverized fuel to the burners.

It will be realized that the simplicity of the unit system involves some sacrifice of flexibility, but power stations are using it successfully with a range of fuels containing from 10 per cent to 35 per cent of volatile matter. The bin-and-feeder system continues to be used in power stations burning anthracite, where combustion conditions require a smaller percentage of primary air than can be used with the unit system.

The mills now in use can be divided into three main groups: the slow-speed ball mill, mostly used in the cement industry, the medium-speed ring-roller and ring-ball types, which are predominant in power stations, and the high-speed impact and attrition types, which have a relatively low capital cost and are used in many small installations.

Apart from the effect of ash, which has already been mentioned, the principal source of reduced mill output is the presence of too much moisture; this should not exceed about 10 per cent if full output is to be maintained. Generally speaking, the drying capacity should be sufficient to reduce the moisture in the coal to within 1 per cent of its inherent moisture.

When powdered fuel was first applied to water-tube boilers, the existing combustion chambers were far too small to permit the air-borne fuel particles to be ignited and completely burned before being carried among the convection heating surfaces, where combustion was checked. To reduce the consequent heat losses, the combustion chambers were increased many times in size, and this was one of the main factors leading to the successful use of pulverized coal.

With modern equipment, such large chambers are not required to obtain complete combustion. If this were the sole consideration, their size could be materially reduced. They are, however, retained in order to reduce the temperature of the ash particles below their fusion point before they enter the convection heating surfaces, where fused ash may give rise to 'birdsnesting', which may rapidly put a boiler out of commission. Indeed, the modern water-tube boiler can be described as a combustion chamber, of which the walls absorb by radiation up to 80 per cent of the heat developed, followed by an economizer and an air heater.

With pulverized fuel firing, about 70–80 per cent of the ash in the fuel is carried out of the boiler by the products of combustion, compared with 20 per cent or even less with stoker firing. During recent years there have been developed in the United States various types of 'slag tap' or 'wet bottom' furnace from which at least 50 per cent of the ash is removed as liquid slag, which can be disposed of with relative ease. The method has obvious advantages, and in certain applications it enables coarser fuel to be used; but difficulties yet remain, and even in the United States, where conditions are more favourable, only 18 per cent of the boilers now on order have 'wet bottoms'.

One bright feature in connexion with pulverized fuel ash is that its composition and quantity are such as to enable a boiler to be kept relatively free from external deposits and to be maintained at full load much longer than a stoker-fired boiler of the same size burning the same coals. In other words, a pulverized fuel boiler has a high 'availability', a factor of paramount importance at the present moment. Against this advantage is the fact that to discharge all the ash from a large pulverized-fuel boiler into the atmosphere would constitute an intolerable nuisance, and most of it must therefore be removed from the flue gases. To remove very fine dust from a gas is, however, an expensive process, which brings no compensating return to the user. Opinions naturally differ as to what is a reasonable efficiency to specify.

High efficiencies of dust removal can be obtained commercially with wet washers, electrostatic precipitators and some types of centrifugal separator. The electrostatic precipitator is usually preferred for powdered coal because of its ability to collect very fine particles without introducing water into the system, but very good results have recently been reported for a mechanical device consisting essentially of a large number of small cyclones. It has been suggested that the best results would be obtained with the two types in series, using the centrifugal apparatus to remove the large particles and to reduce the load on the electrostatic precipitator.

Various methods are used to remove the collected ash and to dump it either on land or at sea, and the possibility of using it for underground stowage is one argument in favour of building power stations at collieries. The dust has also been used as a filler and, with varying success, for brick making; but for such uses it has to compete with cheap and plentiful raw materials such as clay or sand.

Although in Great Britain and in the United States coal is the fuel most used in pulverized form, this method of firing is not restricted to coal. Hard pitch, for example, can be pulverized to give an excellent, almost ash-free fuel. In Germany large quantities of brown coal are pulverized, and practical solutions have been found to numerous special problems, some of which differ considerably from those encountered with bituminous coal.

With regard to future developments, although the use of pulverized coal is firmly established, design is far from stabilized; and there is room for continued research and development at all stages of preparation and utilization. Thus, existing mills absorb many times the power theoretically necessary to give the required increase in the surface area of the coal; burner and combustion-chamber design could be improved to give better ignition and combustion; radiant heat is transferred more efficiently to some parts of the combustion chamber walls than to others; while the scope for improvement in dealing with the many aspects of the ash problem is almost unlimited.

New applications for pulverized fuel may also be found, but they must show a saving in overall costs before they can compete with oil, which has all the

advantages of pulverized fuel without most of its disadvantages. Thus internal combustion engines can be designed to use pulverized coal, but they are not likely to displace oil-fired engines. Similarly, technical success has been achieved in firing marine boilers with pulverized coal, but it has failed to check the tendency to change over from coal to oil. On the other hand, work now in progress in Switzerland and in the United States suggests that it may find a new field in the gas turbine, for both stationary use and for locomotives. It is particularly interesting to learn that it is expected that two full-scale gas turbine locomotives using pulverized fuel will be in operation in the United States by next spring.

INTERNATIONAL CONFERENCE FOR THE PROTECTION OF NATURE

AN International Conference for the Protection of Nature was held at Brunnen, Switzerland, during June 28–July 3, and was attended by sixty-six delegates representing twenty-two countries. Dr. Charles Jean Bernard, president of the Swiss League for the Protection of Nature, was elected president of the Conference, and Prof. Maurice Caullery and Dr. J. Ramsbottom were elected vice-presidents.

It was soon apparent that there was a divergence of opinion concerning both the status of the Conference and the effective steps which could be taken to fulfil its purpose. Many delegates apparently were authorized by their respective Governments to give assent to a draft constitution establishing a permanent inter-governmental Union, whereas others had no official status, as they merely represented societies.

The present position can best be understood from a summary of what had previously occurred. At the Eighth International Zoological Congress at Graz in 1910, Dr. Paul Sarasin raised the question of world-wide Nature protection. A committee was formed which requested the Swiss Government to convene an International Conference. This Conference was held at Berne in 1913, and established an Advisory Commission for the International Protection of Nature, with its centre at Basle. A draft convention was drawn up and signed by the delegates of the seventeen countries represented, but the outbreak of war left it in the air as only nine countries had then ratified it, though five additional signatures were added by December 1914. An attempt was made to revive the Commission at the First International Conference for the Protection of Nature held at Paris in 1923, but failed, presumably because the signatories included ex-enemy countries, whereas Great Britain, France and the United States had not ratified it. In 1928 an International Office for the Protection of Nature was started at Brussels, sponsored by the Governments of France, Belgium, Belgian Congo, Netherlands, Netherlands Indies, Poland and Germany; the Office, which acts as a central office for information, was transferred to the Colonial Institute at Amsterdam in 1945. During the War it suffered many vicissitudes, but is now resuming its activities.

Mention should also be made of the Convention for the Protection of the Fauna and Flora of Africa, resulting from the London Conference of 1933, and a similar one for the Americas; the International Committee for Bird Preservation; and the international agreement preventing the over-fishing of whales.

The Swiss League invited a number of representatives of interested foreign societies to visit the Swiss National Park and other Nature reserves in 1946. So good a response was received that they decided to hold a meeting at Basle, when opportunity was taken to discuss general problems. The necessity for an active organisation was agreed upon, and the Swiss League was asked to arrange an International Conference this year. The difficulties of doing this were apparently not at first realized.

When invitations were received in Great Britain, the Society for the Promotion of Nature Reserves called meetings of representatives of interested societies and discussed the various points which needed clarification. M. J. Büttikofer, secretary of the Swiss League, attended the first meeting and gave an account of the League's general attitude, and Dr. J. H. Westermann a second one, and explained the present position of the International Office. There was unanimous agreement that the Conference called for Brunnen, if held, could be regarded only as exploratory, and that the United Nations Educational, Scientific and Cultural Organisation should be asked to call an International Congress at Paris next year. Their view was later embodied in a series of motions which the British delegates (J. Ramsbottom, N. D. Riley, the Hon. Miriam Rothschild and G. F. Herbert Smith) presented to the Conference.

It was obvious that if a decision were taken immediately the Conference might end with its first meeting, for the delegates were apparently equally divided regarding the authority of the Conference to adopt an international code. It was agreed, therefore, to leave all debatable matters to the final session and to proceed with the drawing up of a draft constitution. A drafting committee was set up under the chairmanship of Dr. G. F. H. Smith. The draft constitution was finally adopted unanimously. Of the nine articles, only that dealing with objects and functions is of immediate interest. This reads:

(1) The Union shall encourage and facilitate international co-operation between Governments, national and international organisations and persons interested in the protection of Nature and natural scenery.

(2) The Union shall promote and recommend national or international action in respect to: (*a*) scientific research relating to the protection of Nature; (*b*) the spread of public knowledge about the protection of Nature; (*c*) the improvement of educational methods best suited to teach the people of the world and especially the children the importance of the protection of Nature; (*d*) co-operation for regional planning with due regard to the principles of the protection of Nature; (*e*) the creation and conservation of national parks, Nature reserves and natural scenery; (*f*) the preservation of wild life and its natural environments; (*g*) the preparation of a world-wide convention for the protection of Nature.

(3) The Union shall collect, analyse, interpret and disseminate information about the protection of Nature.

(4) The Union shall publish and distribute to Governments, national or international organisations concerned with and persons interested in the protection of Nature, documents, legislative texts, scientific studies and information of any kind regarding the protection of Nature and especially the preservation of fauna, flora, natural scenery and natural monuments.

As was to be expected, the general discussions provided evidence of the need for a wide view of the problems of Nature protection. Thus, a remark made in submitting the British proposals that Nature protection meant not only the preservation of communities of plant and animal and the amenities, but might also affect man's welfare and even his existence, was expanded by Mr. G. Brewer, of the New York Zoological Society, with specific examples from the American continent which illustrated what may be termed the global view, and Governor G. C. Guibet, of the French Colonial Service, who stressed the political aspects.

The wisdom of postponing discussion of controversial matters until the end of the meeting gradually became obvious, and what amounted to a well-organised opposition to the 'obstructional' attitude attributed to the British delegates was so far converted by the realization that all had the same object in view and that no time had been lost during the Conference, that little difficulty was found in making the few adjustments necessary for complete agreement. The proceedings on the last morning were soon concluded. It was unanimously agreed that the Swiss League should continue to act as the agent for the provisional organisation and to carry out all necessary business as provided for by the provisional constitution. The League shall immediately send the draft constitution to the United Nations Educational, Scientific and Cultural Organisation asking for it to be transmitted to all Governments inviting them to communicate to the Organisation whether they can accept the draft constitution with or without amendments. The Organisation is requested to convene a Congress at Paris in July 1948 to discuss and finally accept a constitution based on the draft constitution. A request is to be sent to the Swiss Government asking that it shall communicate with the signatories of the 1913 Convention asking for its cancellation.

All that remained was for the Conference to pass a well-earned vote of thanks to Dr. Bernard for the excellent way in which he had presided, and to the Swiss League and its officers for their hospitality, initiative and labours.

Further matters call for comment. An international committee was formed to consider the various terms used in Nature protection, to collate national usages and formulate an international nomenclature.

Dr. R. Videsott gave an account of the Italian National Park at Gran Paradiso. At present there are nine hundred chamois and six hundred ibex protected by sixty gamekeepers. Owing to lack of funds, the Ministry of Agriculture and Forestry has had to discontinue the maintenance of the gamekeepers, and unless private subscriptions are available this most important European game reserve will be denuded of its treasures.

One of the societies sending delegates to the Conference was the Nederlandse Jengdbond voor Naturstudi, a youth organisation with four thousand members between the ages of twelve and twenty-three, which has the protection of Nature as one of its main aims. It has a central office and eighty-five subsidiary centres, and a very efficient organisation with camps, lectures and its own periodical.

At the end of the Conference the majority of the delegates spent several days visiting the Swiss National Park. To their dismay they learned that there is a proposed scheme for a hydro-electric installation which will dam up the streams in the upper reaches of the Park and inevitably convert this famous forest region into a stony wilderness. Swiss naturalists are not alone in asking *cui bono* ? They saved the Lac de Sils, menaced by commercial development, after indemnifying the local communes by the profits from the unrestricted sale of chocolate medals—chocolate then being rationed—and had sufficient funds over to construct a research laboratory. May the public interest again be successfully brought to bear, for the preservation of its National Park means not only the retention of a beauty spot with its fauna and flora, but also the continuance of a living laboratory rich with promise of data valuable for the proper development of the country's forests.

J. RAMSBOTTOM

MICROSEISMS AND ATMOSPHERIC OSCILLATIONS

By ERNEST TILLOTSON

THE surface of the earth is in constant movement with amplitudes of a few thousandths of a millimetre, and this movement is picked up and registered by instruments set up to record the passage of waves caused by earthquakes. An earthquake starts from a definite focus, but a microseism is any ground movement which has not been started by an earthquake. Bertelli, who first used the name 'microseism' in 1878, probably intended the name to cover only those waves of 5 ± 2 sec. period which were somewhat regular in character and which, beginning with small amplitudes, grew in intensity and then died out in a length of time up to a few days.

The Japanese at one time considered microseisms to be stationary waves; but J. J. Shaw and others showed that they are progressive waves. They have a velocity of 2·5–3·5 km./sec. Lee did a considerable amount of work on microseisms and came to the conclusion that they were largely composed of Rayleigh waves. He then attempted to use this fact ("On the Direction of Approach of Microseismic Waves", *Proc. Roy. Soc. London*, A, **886**, 183; 1935) to find the source of microseismic waves. To get the direction from which the microseismic waves were approaching the observatory, Lee assumed them to be Rayleigh waves and noted the phase differences on the three-component seismographs. Thus if Rayleigh waves were approaching from the north, the sequence of ground movement should be up north down south; if from the south, the sequence should be up south down north, and so on. Lee had some difficulty, as he found the phase differences between the components of the microseisms to be variable, although the values appropriate to the general direction of approach were dominant. He used the dominant direction so obtained. His difficulties were probably due to the approaching microseisms not being completely Rayleigh waves, as there was some motion across the direction of propagation. Rayleigh waves were, however, dominant.

On account of the exigencies of war service, this work was not continued; but Lee and also J. J. Shaw were definitely of the opinion that the character of microseisms was influenced by geological structure. Banerji and Zanon thought not. Geological faults hinder the passage of microseisms in the Caribbean,

and damp out microseisms. Since microseisms have a wave-length of 12–25 km., it is thought that the faults must go a considerable depth. The same microseismic movement rarely extends over a whole continent, and always appears to have something to do with atmospheric disturbances. Lee noticed that microseisms had larger amplitudes and longer periods in winter than in summer in the British Isles. In 1937, Baird at Christchurch, New Zealand, experimented with a modified condenser microphone and obtained records of air-pressure pulsations with a range of 0·002 mm. of mercury pressure which always appeared to lag behind the microseisms. The air-pressure pulsations agreed in period with the concurrent microseisms and varied directly in size with them. At Samoa, microseisms seemed closely related to synoptic charts. Baird suggested a study of convection cells in air of adiabatic or superadiabatic lapse-rate. These sometimes provide enormous quantities of energy.

Microseisms may begin in a number of ways, and up to the present time the following have been considered most common. E. Weichert in 1904 noticed the similarity of the characteristics of microseisms and sea waves, especially the close agreement between the periods, and suggested that microseisms were caused by the impact of sea waves on rock-bound coasts. Gutenberg followed this up by suggesting that the microseisms of north-west Europe were caused by the beating of the waves on the Norwegian coast, and the microseisms of western America by the beating of the waves on the rocky Canadian Pacific coast. Gherzi and Banerji noticed that large microseisms often occurred when a storm was far out at sea and not near the coast, Gherzi noting that large microseisms at Zi-ka-wei occurred when there were cyclones in the surrounding regions, but not when the sea waves were caused by monsoons. It has been suggested by Gherzi and Bradford that microseisms may be caused by atmospheric oscillations or 'pumping' near the centre of a cyclone. Banerji noticed that the microseisms were great when a storm was approaching India over the sea, but that they were insignificantly small when the storm was over the land. All cyclones do not produce the same intensity of microseismic disturbance, as was pointed out by Lee when he directed attention to the synoptic charts of the British Isles for 7 hr. on January 3, 1930, and 18 hr. on January 11, 1930. These are very similar, except that the barometric gradients are steeper on the former date. Microseisms on both occasions apparently started at the low-pressure area between Iceland and Scotland, but the microseismic amplitudes on the latter date were nearly treble those on the former date in north-west Europe. Ramirez found that group microseisms of 4–6 sec. period arrived at St. Louis whenever a hurricane or an intense extratropical cyclone moved over deep water at sea. During 1938 the direction of approach was never from a storm over land. The New England hurricane of September 1938 caused microseisms while it was at sea, but not when it was over land. The direction of approach was always from the centre of the hurricane and not from the surf on the coastline. Suzuki and Omori used three 'leaking microbarographs' at three stations in Japan four miles apart, and found air oscillations of wave-lengths 13–25 km. with velocity 20–50 metres per sec. and periods 6–11 min. at levels 3–8 km.

Since microseisms appeared to originate in areas of low barometric pressure at sea, the U.S. Navy decided in 1943 to attempt to track such storms in the Caribbean Sea by means of microseisms, using the tripartite station method with precisely simultaneous timing suggested by J. J. Shaw in England in 1920, and used on group microseisms of 4–6 sec. period by Ramirez, with an extra station at St. Louis, U.S.A., in 1940. This method has the advantage of being independent of the type of waves, and makes the seismograph a meteorological instrument. The U.S. Navy placed the project in the hands of Lieut.-Commander Marion H. Gilmore, who set up three such stations at Guantanamo Bay, Cuba; San Juan, Puerto Rico; and Richmond, Florida. Each tripartite station gave the direction of the storm, and by means of the three stations the position of the storm centre was obtained with some certainty and its path traced as the storm moved. Each tripartite station consisted of three seismographs orientated in the same direction, and one in each of three vaults at the vertices of an equilateral triangle of 8,000 ft. side. The seismometers were of the Macelwane-Sprengnether type, each consisting of a boom assembly, a coil magnetic unit and the damping magnetic unit; and the maximum synchronous magnification of the instruments when operating at a period of 6 sec. was about 2,500. For the three seismometers there was a central recorder and simultaneous timing. This made for convenience of reading, as quick reading was essential. The cost of the whole project was about £19,000, which is small compared with the damage done by one hurricane such as that of September 1938, which caused property damage of some £75,000,000. With this success in mind, the U.S. Coast and Geodetic Survey is at present conducting an intense world-wide research programme on microseismic disturbances.

Following the work of Miche in 1944 the British Admiralty Research Laboratory has been doing important work on the connexion between sea waves and microseisms.

The discussion on atmospheric oscillations at the Royal Astronomical Society on January 24 (see *Nature*, March 15, p. 357) was concerned with the earth's atmospheric tide caused by the moon, and solar daily oscillations in the earth's atmosphere; it did not throw any light on atmospheric oscillations which would be likely to cause microseisms.

OBITUARIES

Mr. R. I. Pocock, F.R.S.

Mr. R. I. Pocock, superintendent of the Zoological Society's Gardens during 1904–23, died suddenly at his home in London on August 9 at the age of eighty-four. He had been working as usual at the British Museum (Natural History) only the previous day.

Reginald Innes Pocock was born on March 4, 1863, at Clifton, Bristol, and was the fourth son of the Rev. Nicholas Pocock. He was educated at St. Edward's School, Oxford, Frank Townsend's School, Clifton, and University College, Bristol. In 1885 he joined the staff of the British Museum (Natural History) and was placed in charge of the Arachnida and Myriopoda. He soon became well known in these groups as a result of numerous publications, including the volume on Arachnida in the "Fauna of British India", and on Chilopoda and Diplopoda in the "Biologia Centrali-Americana". He also con-

tributed articles on these and other invertebrates to natural histories, scientific journals and the "Encyclopedia Britannica".

His main interest, however, was in the higher vertebrates, and this was further stimulated by trips to Spain and the Balearic Islands with Oldfield Thomas to collect small mammals. Much to the regret of his colleagues, he resigned from the Museum in 1904 to take up the post of superintendent of the Zoological Society's Gardens.

Here his first research was on mimicry in insects and their palatability to birds, which was almost his last contribution to invertebrate zoology. His new post gave him opportunities of studying live mammals in the collection under his care, and in the prosectorium he could carry on researches on the more detailed anatomy of the groups in which he was interested, especially Primates, Carnivora and Ungulata.

In 1911 he was elected to the Royal Society, shortly after the publication of what Pocock himself regarded as his most important paper, "On the Specialized Cutaneous Glands of Ruminants". Among other of his many papers, which appeared in the *Proceedings of the Zoological Society* and other journals, special mention should be made of that "On the External Characters of the Lemurs and *Tarsius*" and another "On the Classification of Existing Felidæ".

Pocock retired from his post at the Zoological Society in 1923 and returned to the British Museum (Natural History) as a 'temporary scientific worker'. He devoted himself to the study of his favourite groups of mammals, and entered into correspondence with naturalists and sportsmen in many parts of the world with the object of filling gaps in the national collection. He contributed the volumes on monkeys and Carnivora in the "Fauna of British India" and was also preparing a volume on the Ungulata, and a "Catalogue of the Felidæ in the British Museum".

Apart from his numerous scientific publications Pocock also found time for more popular writing, and was for many years natural history editor of *The Field*. His untiring energy remained until the last, the Zoological Society having received from him the MSS. of three papers within the past two months.

He had considerable artistic talent, possibly inherited from his great-grandfather Nicholas Pocock, marine artist by appointment to George III, and he illustrated many of his own papers and articles.

He was deeply interested in sport, winning many prizes in athletics in his youth. As a Rugby footballer he gained his cap for Gloucestershire, and later, after taking up residence in London, he played for Blackheath in its first XV until about 1890. This interest in sport he retained until the day of his death, which he had intended spending at Lords.

Pocock married, in 1889, Constance, daughter of Mr. Thomas Osborne, and is survived by one son.

EDWARD HINDLE

Dr. Alex Müller

DR. ALEX MÜLLER, who died on July 2, at the age of fifty-eight, received his early training in physics and mathematics in Zurich, where he took his doctorate in 1915 by a thesis entitled "Messungen der thermischen Ausdehnung von kristallisiertem Quarz und von Gold zwischen 18 und 540°". Later he studied in Göttingen and then in the Cavendish Laboratory, Cambridge.

Before coming to Britain he had acquired a sound knowledge of X-ray techniques; he had made one of the earliest determinations, by X-ray methods, of the value of Planck's constant, and he had experience in the design of X-ray tubes. While at the Cavendish he was associated, in its early stages, with the work by Miss C. Elam and Prof. G. I. Taylor, which later formed the substance of the Bakerian Lecture for 1923, and he himself made sodium crystals and experimented on their plastic deformation. He also became interested in the determination of crystal orientation by X-ray methods, one of the more important of present-day industrial applications of X-ray crystallography.

In 1922 he joined the staff of University College, London, where Sir William Bragg was Quain professor of physics; and in 1923 he moved with Bragg's research team to the Royal Institution, where he worked for the rest of his life, first as research assistant, then, from February 1928, as assistant director, and, from November 1946, as deputy director of the Davy Faraday Research Laboratory.

His contribution to the work of that team was unique. W. H. and W. L. Bragg had opened up an immense field of investigation in the twin sciences of X-ray spectroscopy and X-ray crystallography. They had used ionization methods with great success in the first instance, but for many purposes these were proving inadequate. Müller, however, had had considerable experience of photographic methods; in 1921 he had made wave-length measurements of the L spectrum of mercury, using an X-ray tube with a liquid mercury anticathode; and he now devoted himself on one hand to the development of equipment for the photographic technique of structure analysis, and on the other to the practical application of that technique to the study of the structure and properties of long-chain carbon compounds. His work, carried out partly in collaboration with Dr. G. Shearer, on materials prepared by Dr. Saville and later by Miss Gilchrist, gave, for the first time, definite information of the dimensions of molecules of the fatty acids and of the n-hydrocarbons, by the use of finely powdered material. Later he succeeded in growing single crystals of some of these compounds and in determining their structures more completely. But his greatest achievements were on the technical side. Gas-tubes, induction coils, vacuum pumps and X-ray spectrometers were made to his design in the Davy Faraday Laboratory, and it was largely because of his initiative that an increasing number of research workers could be supplied with apparatus at relatively small cost. Later he developed the powerful X-ray tubes with rotating, water-cooled anticathodes, using inputs of 5 kw. and 50 kw. respectively, with which he investigated the elastic properties of solid n-paraffins, and on which also most of the research into the thermal vibrations of atoms in crystals was carried out.

A succession of research workers at the Davy Faraday Laboratory has owed much to his unfailing advice and to his skill in technical matters. They would wish to remember him not so much in his later years, when the shadow of ill-health and of war-time anxieties had fallen upon him, but in the earlier days when he delighted them with stories of his beloved Switzerland and even, on occasion, with his yodelling. He was a competent skier, and before the War he spent nearly all his holidays in his home country, of which he remained a national. A lover of country life, he had had a keen interest in biology ever since his student days, and he sometimes regretted the fact that he never had the opportunity of carrying out research in that field.

K. LONSDALE

NEWS and VIEWS

British Association at Dundee

On Wednesday, the annual meeting of the British Association, held this year at Dundee, was brought to a close. The meeting opened on August 27, and was the first full meeting to be held since 1939; in that year, it will be recalled, the annual meeting opened also in Dundee, but was abandoned on the declaration of war. It was thus appropriate that the Association should mark the renewal of its full activities by meeting at Dundee, though nevertheless the generosity of the city in once more offering itself as host must not be overlooked. The formal opening of the meeting with the delivery of the presidential address on the evening of August 27 was preceded, at noon, by a civic ceremony in the Caird Hall, at which the Lord Provost conferred on Sir Henry Dale, president of the Association, the freedom of Dundee; this distinction, as Sir Henry remarked, not only honoured him but also the British Association. The Lord Provost and Corporation also gave a civic reception for the Association on the evening of August 28, and a dinner on the following evening to selected visitors, at which Sir Henry Dale, Sir Richard Gregory (immediate past-president of the Association) and Dr. Kirtley F. Mather, of Harvard, who had just delivered the British and American Association Lecture, paid just tribute to the hospitality of Dundee and its citizens. Local interest in the meeting was shown by the fact that of the total registration of 3,000 announced by Sir Henry Dale on August 27, no less than 1,770 were from Dundee and the neighbourhood; this latter figure exceeded that for 1939 by more than 250 and constitutes a record for meetings in Great Britain outside London. Sir Henry Tizard was elected president of the British Association for 1948, when the annual meeting will be held at Brighton. Sir Henry is chairman of the Advisory Council on Scientific Policy and of the Defence Research Policy Committee (see *Nature*, February 8, p. 191); his acceptance of the office of president of the British Association ensures that the Association will be fully in touch with scientific developments and will not lack energetic leadership during the coming year.

During the meeting, a special graduation ceremony was held in Dundee and the honorary degree of LL.D. of the University of St. Andrews was conferred on the following: Sir Edward Appleton, secretary, Department of Scientific and Industrial Research; Sir Lawrence Bragg, Cavendish professor of experimental physics, Cambridge; Sir Henry Dale, president of the British Association; Sir Alexander Fleming, professor of bacteriology, University of London; and Prof. Angus Robertson Fulton, formerly principal of University College, Dundee, and emeritus professor of engineering.

Development Fund for the British Association

At the close of his presidential address, Sir Henry Dale launched an appeal on behalf of the British Association for a development fund of £100,000 for the advancement of science. It was appropriate, he said, that the appeal should be announced in the Caird Hall, Dundee, where he was speaking, because it was Sir James Caird, who gave the hall to the city, who also gave the British Association in 1912 its first endowment fund. This was followed by other gifts, such as that in 1926 of £10,000 by Sir Alfred Yarrow, who, however, made it a condition that the capital and interest should be expended in twenty years. The Association now requires substantial funds to enable it to continue to discharge its functions. Hitherto, its working expenses have been small, chiefly because a large part of the cost of the annual meetings has been provided by the generous hospitality of the cities where they were held. It has no significant reserves to meet the present rising costs or to enable it to undertake new activities. An appeal is accordingly being made for a development fund of £100,000 to be used under the direction of the Council of the Association for the advancement of science. Among the specific purposes for which funds are urgently needed are the support of certain aspects of research not adequately covered by specialist and other bodies; promotion of contacts between British and other men of science; the extension of the scheme whereby senior science students at universities and colleges are enabled to attend annual meetings of the Association; provision of better accommodation than the wholly inadequate offices at present occupied by the Association; increased endowment to maintain Down House, the home of Charles Darwin, with its priceless collection of Darwiniana; and provision of a central organisation for the dissemination in Britain of scientific information. Particulars of the appeal can be obtained from the Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

John Couch Adams and the Discovery of Neptune

In a small book of forty-three pages, by Sir Harold Spencer Jones, the Astronomer Royal (Cambridge University Press), many misunderstandings regarding Airy and Adams have been rectified, so those who desire an unbiased view of the matter should read the book. Most people have been inclined to blame Airy for not giving more consideration to Adams when he announced the results which he had obtained, but it is shown that Airy was not really to blame and that the failure of Adams to reply to certain questions relating to the radius vector of Uranus was probably responsible for his loss of the sole glory of the discovery of Neptune. Airy seems to have behaved with remarkable courtesy to Adams, who was of a retiring disposition and who realized later what he had lost by not answering Airy's letter. Incidentally, it is shown that Challis did not appear in a very creditable light when all the facts were made known and that Le Verrier's subsequent behaviour could scarcely be described as becoming in a man of his ability. However, the painful controversy having ended, astronomers can only endorse the words of Sir John Herschel, addressing the Royal Astronomical Society in 1848, and speaking of Le Verrier and Adams: "May they both long adorn and augment our science and add to their fame, already so high and pure, by fresh achievements".

National College of Horology and Instrument Technology

The National College of Horology and Instrument Technology is to commence functioning on October 6. It will be housed in the Northampton Polytechnic, London, which for fifty years has been concerned with the training of craftsmen in watch and clock repairing. The College is one of the national centres promoted by the Ministry of Education to cater for those specialized industries which are of great

importance in the country's economy but which are too scattered to justify numerous small training centres. A representative board of governors under the chairmanship of Sir Allan Gordon Smith has been working for twelve months on preparations for the opening of the College, and a prospectus has been prepared which will be published shortly. The two main courses to be offered are: a three-year general full-time course for youths of sixteen to seventeen who have attained School Certificate standard; and a two-year advanced full-time course to follow the general course or to be entered directly by students who have reached ordinary National Certificate standard in engineering. Facilities will also be available for short production courses, post-graduate study and horological research, and also for part-time classes.

The National College is intended as the source from which will emerge the potential managers, designers and other executives of the industry in Great Britain. It will be equipped with first-class modern machine tools for the production of horological mechanisms, and laboratories for design and measurement. The non-specialist subjects will be catered for by the normal extensive facilities of the Polytechnic. Fees for the full-time courses are at the rate of £60 a year, and it is intended in due course to establish a liberal scholarship scheme. The training of craftsmen for the industry will continue to be effected locally by co-operation between the factory and the neighbouring technical college.

More Warmth with Less Fuel

It is common knowledge that open coal fires radiate only a small fraction of the heat available from bituminous coal, most of the rest being carried up flues to the outside air. In many countries climatic conditions or the need for thrift enforce various means to avoid waste of fuel. Independent stoves are placed in living-rooms or heat is distributed throughout buildings by means of warm water or air propelled either mechanically or by gravitational action. To-day circumstances are compelling Britain increasingly to adopt similar methods. The growing use of closed stoves is a familiar example whereby 65 per cent of the heat of combustion can be distributed in a simple manner, at the cost of losing, wholly or partly, the heating by radiation from the glowing fuel. Another method, used in the so-called 'convector' fires, is an attempt to combine the merits of the open fire with recovery of heat from the products of combustion. These are led through a flue system whereby their content of heat is extracted and used for remote space heating. In some respects, this is analogous to a system of house warming common in the United States, where heat generated in the basement is allowed to percolate throughout by simple gravitation. The widespread construction of new houses offers advantages in such methods, advantages which are being taken.

On June 24, Mr. A. F. Dufton, addressing the Institution of Heating and Ventilating Engineers, recalled earlier observations on a pattern of open grate described as a "Cheminée de Nancy". The design was such that the heat radiated by the burning fuel was supplemented by heat extracted from the products of combustion before leaving the grate. The appliance consists of a twelve-inch stool grate with refractory back and cheeks. Above this stands an upwardly tapering metal trumpet which has an opening in front leaving the fire visible. The top of the trumpet makes a close fit into a flue opening. All the products enter the chimney through the trumpet, which, becoming heated, supplies an additional area for space heating by convection and radiation. The performance as a warming agent of this grate, when burning two pounds of coal per hour, surpassed that of a normal grate consuming three pounds per hour. The advantage of increasing the area of an appliance was also shown by fixing behind an anthracite stove a metal drum 22 in. high and 14 in. in diameter. The products of combustion passed through the drum, the temperature of which was raised. The thermal efficiency of the stove was thus increased from 60 to 80 per cent. In discussing the merits of internal insulation, Mr. Dufton said that an adequate thickness of material of low thermal conductivity caused a rise in temperature of the surface and increase of comfort. Small thermal capacity conferred a quick response to change.

Crystal Structure Models

Progressive school teachers as well as university workers and industrial chemists will be interested to learn that a company, known as Crystal Structures, Ltd., The Broadway Works, Farnham Common, Buckinghamshire, has recently been formed to manufacture crystal structure models. It is intended later to undertake the manufacture of various types of models, employing a considerable variety of materials, but at present production is confined to one-inch, drilled, wooden balls separated by metal spokes which indicate the co-ordination. The colours used conform to the recommendations of the X-ray Analysis Group of the Institute of Physics. In addition to a standard set of models for teaching or museum display, a set of fifty loose spokes and balls drilled along the twenty-six axes of symmetry of the cubic system are available for students to build models for themselves. Individual models can be made to order. It is claimed that errors of construction do not exceed 4 per cent in the dimensions of the unit cell, and the direction of the spokes is correct to within 2°. Inquiries may be made to the Works or to Dr. Nora Wooster, Brooklyn Crystallographic Laboratory, Cherry Hinton Road, Cambridge.

Low-Pressure Amplifier and Electro-pneumatic Converter

An eight-page illustrated folder received from Messrs. Negretti and Zambra, Ltd., 122 Regent Street, London, W.1, describes the Negretti and Zambra low-pressure amplifier and electro-pneumatic converter. The low-pressure amplifier is a pneumatic means of amplifying a very low pressure to a pressure of 5 lb./in.^{2} and transmitting the result to a receiving instrument. It can be used for measuring or controlling absolute pressure, differential pressure, air or gas flow, air–gas ratio and specific gravity. The electro-pneumatic converter converts the voltage of a thermocouple or similar generator to a pressure of 1–5 lb./in.^{2}, thus furnishing sufficient force to actuate a recording mechanism. It can be used for humidity measurement and control.

Engineering Degree Courses for Ex-Servicemen

Writing with regard to earlier notes on engineering degree courses for ex-Servicemen and those engaged in industry (*Nature*, **159**, 497; 1947), Mr. O. S. Puckle states that the results of the inquiry have been sent to the Ministry of Education, which has handled

the matter sympathetically. The Ministry is communicating with the local councils concerned with a view to the provision of classes at times more convenient for those who cannot be released for day-time attendance except on Saturday mornings. However, the final responsibility for the organisation of courses rests with the individual teaching establishments. It is hoped that suitable arrangements can be made in time for the forthcoming winter sessions; but it is regretted that it is only in certain parts of the country that the numbers of applications are sufficient to permit of any action being taken.

Queen Victoria Museum and Art Gallery, Launceston, Tasmania

THE 1945–46 annual report of this Museum contains a reference to the proposed extension of the Museum's educational service. This service, under the new scheme, will embrace a greater and more comprehensive range of subjects than has been the case hitherto. It will, also, be extended to all schools, whether public or private, and in this connexion the note states, "Liaison with the schools is a fundamental activity of the Museum and Tasmania is considered to be in the forefront of such work in Australia". The City Council has also approved plans for certain works of renovation which will result in more gallery and working space, and in the better presentation of the collections.

Vocational Education in the United States

THE Federal Security Agency of the U.S. Office of Education has issued a book of 329 pages on "Vocational Education in the Years Ahead" (Washington: Gov. Printing Office, 50 cents), which is the report of a committee appointed to study post-war problems in vocational education, the committee being large and representative. The vocations selected for examination and report were agriculture, business, homemaking, industry and guidance, that is, guidance in the matter of occupational information. The whole publication is replete with authoritative counsel.

International Congress of Zoology, 1948

THE executive committee of the Thirteenth International Congress of Zoology has announced that the Congress will be held in Paris during July 21–27, 1948. An attempt was made to arrange that the two Congresses, of Genetics and of Entomology, to be held in Stockholm in July and August 1948 respectively, should be brought closer together so that the Congress of Zoology could either precede or follow them, but this proved impossible. The Congress of Zoology will meet in the following sections, the sectional presidents' names being given in brackets: general zoology (Prof. A. Vandel); evolution and genetics (G. Teissier); cytology and protistology (Prof. E. Fauré-Frémiet); comparative and experimental embryology (E. Wolff); vertebrates (*a*) comparative anatomy (Prof. M. Prenant) and (*b*) systematics and ecology (Prof. E. Bourdelle); invertebrates except insects (Prof. L. Fage); entomology (Prof. R. Jeannel); applied zoology and parasitology (Prof. A. Vayssière); zoogeography and palæontology (Prof. C. Arambourg); nomenclature (M. Fischer-Piette). The president of the Congress will be Prof. M. Caullery, professor of zoology at the Sorbonne, president of the permanent committee of the Congress of Zoology; and the secretary-general is Prof. Fischer-Piette, 55 rue de Buffon, Paris V^e^., from whom particulars can be obtained.

University of London : Appointments

THE following appointments in the University of London have been announced: Dr. William Burns, officer-in-charge of the Royal Naval Physiological Laboratory, to the University chair of physiology tenable at Charing Cross Hospital Medical School; Mr. W. G. East, to the University chair of geography tenable at Birkbeck College; Prof. L. A. Reid, professor of mental and moral philosophy at King's College, Newcastle-on-Tyne, to the University chair of philosophy of education tenable at the Institute of Education; Dr. H. N. Rydon, attached to the Medical Research Council's Unit for Bacterial Chemistry at the Lister Institute, to the University readership in organic chemistry tenable at Birkbeck College; Dr. David Slome, senior lecturer in physiology at the Middlesex Hospital Medical School, to the University readership in physiology tenable at the School; Dr. E. W. Walls, senior lecturer in anatomy in the University College of South Wales, to the University readership in anatomy tenable at Middlesex Hospital Medical School.

The title of professor of bacteriology as applied to hygiene has been conferred on Dr. J. C. Cruickshank in respect of the post held by him at the London School of Hygiene and Tropical Medicine. The title of reader in medical mycology in the University has been conferred on Dr. J. T. Duncan in respect of the post held by him at the London School of Hygiene and Tropical Medicine. The title of reader in social economics in the University has been conferred on Mrs. Gertrude Williams in respect of the post held by her at Bedford College.

Announcements

PROF. HERMANN WEYL, recently of the School of Mathematics, Institute for Advanced Study, Princeton University, and Prof. George Polya, professor of advanced mathematics in the Technical Highschool, Zurich, have been elected *correspondants* for the Section of Geometry of the Paris Academy of Sciences.

MR. GEORGE S. CARSDALE, of the Forestry Department, Gold Coast, and well known as a collector of animals, particularly reptiles, has been appointed assistant superintendent of the Zoological Gardens, Regent's Park, London.

THIS year, the Royal Photographic Society's annual exhibition of photography will be divided into two parts: Part 1, pictorial and colour, September 13–October 5; Part 2, scientific, Nature, record and technical, October 11–November 1. The exhibition will be held at the Society's house, 16 Princes Gate, London, S.W.7.

THE Faraday Society has arranged a General Discussion on "The Labile Molecule", which will be held in the Physical Chemistry Laboratory, Oxford, during September 23–25. As usual in such discussions, many foreign visitors have promised contributions. Particulars of the meeting can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, London, W.C.1.

ERRATUM.—The author of the communication "Effect of Bending on Selenium Rectifier Disks" (*Nature*, Aug. 9, p. 197) was P. Selényi alone; his address should have appeared as Eng. Nicholas Székely's Electrical Undertaking, Rectifier Laboratory, Üröm-u. 24/28, Budapest III.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Unit for Solar Radiation Work

In solar radiation work the unit called the gram calorie per square centimetre per minute is very frequently used; for longer time intervals, such as an hour or day, for example, the gm.cal./cm.²/hr. or gm.cal./cm.²/day is used, when appropriate. These units are somewhat cumbersome to write and even more awkward to say.

A more convenient unit is therefore needed. According to Linke[1] the 'langley' has been proposed to designate the gm.cal./cm.²/min., in honour of Dr. Samuel P. Langley, who, as the first director of the Astrophysical Observatory of the Smithsonian Institution, contributed greatly to the study of solar radiation and its depletion by various gases in the earth's atmosphere.

However, in view of the need of considering longer time intervals than a minute, it is herewith proposed that the 'langley' be defined as the gm.cal./cm.², where 'gm.cal.' denotes the 15° C. gm.cal. It is also proposed that the written abbreviation of 'langley' be 'ly'; to shorten the word in other ways might tend to confuse it with other units.

Having adopted the new unit, we may now speak of the 'langley per minute', the 'langley per hour' (and so forth), which will be written as 'ly/min.' and 'ly/hr.'

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Office of the Quartermaster General,
War Department,
Washington, D.C.

SIGMUND FRITZ
Meteorologist,
U.S. Weather Bureau,
Washington, D.C.

WILLIAM P. MILLEN
Major,
Air Corps,
Washington, D.C.

[1] Linke, F., Vorbereitende Betrachtungen, "Handbuch der Geophysik", **8**, Lf. 1, 30 (Berlin, 1942).

Observations Underground of Penetrating Cosmic Ray Showers

MEASUREMENTS have been made on two types of penetrating event in our laboratory on Holborn Tube station. The laboratory is approximately 100 ft. under clay. The measurements were as follows.

(*a*) *Penetrating Showers.* For these measurements, a seven-fold counter arrangement was used, illustrated in Fig. 1. This is identical with that used by Jánossy and Broadbent[1] in their study of these showers at sea-level at Manchester. There are three trays of eight counters each. The top tray is divided into three independent groups, while the middle and bottom trays are each divided into two groups as shown. Seven-fold coincidences, consisting of the simultaneous discharge of at least one counter in

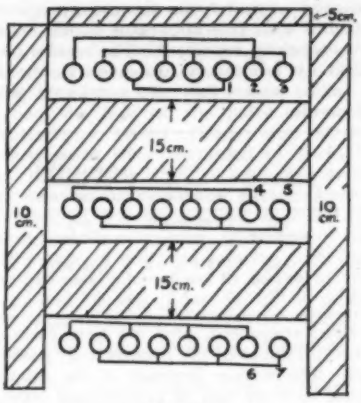

Fig. 1.

each group, were recorded. Between the top and middle, and middle and bottom, trays are lead screens 15 cm. thick, so that in order to produce genuine seven-fold coincidences, at least two particles capable of penetrating 30 cm. of lead must occur simultaneously. In our arrangement, the ends and sides of the set were screened with 10 cm. of lead to eliminate counter coincidences that could have been caused by showers produced by electrons knocked-on by mesons with their axes at a large angle to the vertical. The top layer of lead, for the production of showers, was 5 cm. thick. With this thickness of producer, Jánossy and Broadbent recorded a rate of 0·4 coincidences per hour at sea-level. In 45 days, we have not recorded any penetrating showers underground.

Periodical checks of the satisfactory operation of the apparatus were performed.

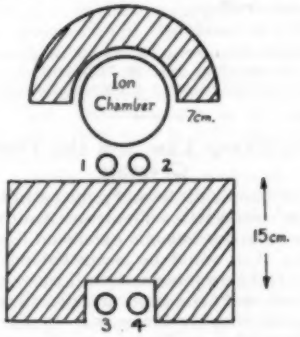

Fig. 2.

(*b*) *Penetrating Bursts.* The apparatus for these measurements is indicated in Fig. 2. It consists of a small ionization chamber filled with pure argon to 40 atmospheres pressure. Close above the chamber is a 7-cm. thick lead screen. Under the chamber is a set of four counters, the lower two being screened by 15 cm. of lead.

Ionization bursts were recorded using an amplifier and cathode ray oscilloscope. The minimum size of burst recorded was that corresponding to the passage of 20 fast rays through the chamber. Four-fold counter coincidences were recorded, and in addition, bursts accompanied by four-fold counter coincidences

were indicated separately on the oscilloscope record. Measurements with this apparatus at sea-level have already been briefly reported[1]. The results obtained in the Holborn laboratory are given in the accompanying table, where they are compared with the sea-level results.

	Bursts size (> 20 rays)	4-fold counter coincidences	Bursts accompanied by 4-fold coincidences	Total time
Sea-level	8·5 per hour	45·5 ± 1 per day	0·5 per day	36 days
Underground	0·52 per hour	9·6 ± 0·3 per day	0 in 100 days	100 days
Ratio	16	4·8	—	

With this experiment, also, we have been able to record no production of penetrating particles in 100 days. The strong decrease of the intensity of penetrating showers and of penetrating bursts with depth supports the hypothesis put forward[1] to the effect that the penetrating showers are produced by primary nucleons. If the mean free path of the nucleons is about 100 gm./cm.^{2}, then the intensity underground is expected to be e^{-30} times that at sea-level and thus negligible.

The observations are, on the other hand, clearly incompatible with an assumption to the effect that penetrating showers are given rise to by the hard component itself.

(c) *Frequency of Ordinary Bursts.* A further point of interest lies in the unexpectedly large ratio of the sea-level and underground burst rates under 7 cm. of lead. A similar ratio has already been reported by Chou[3]. It is hoped to discuss this point in greater detail later. We wish here to point out the complete absence of the production of penetrating particles recorded in each experiment.

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[2] George and Jánossy, *Phys. Rev.*, **70**, 773 (1946).
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Andrade's Creep Law and the Flow of Zinc Crystals

Studying the plastic flow of polycrystalline metallic wires under constant tensile stress, Andrade[1] showed that, after an instantaneous extension accompanying loading, the flow could be separated into two components: (1) β-flow, characterized by $\gamma \propto t^{1/3}$, where γ is the strain and t the time, and (2) a flow, described as viscous, obeying the law $\gamma \propto t$. It was thus found that the extension could be expressed generally by the equation,

$$l = l_0(1 + \beta t^{1/3}) \exp \varkappa t, \quad . \quad . \quad (1)$$

where l is the wire length at time t, l_0 is the length immediately after loading, and β and ϰ are coefficients of flow. The exponential term is introduced to allow for the increase of gauge-length with extension.

To extend these results to single crystals, several modifications have to be made, the most important of which is that the shear stress acting on the glide planes in the glide direction must be maintained constant; under a constant tensile load the rotation of the glide planes accompanying glide causes the resolved shear stress on these planes to increase in a way given by

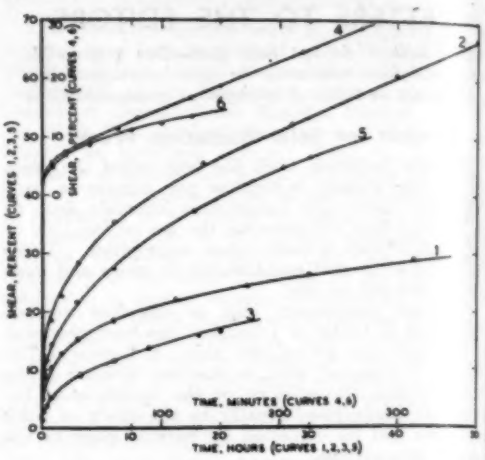

Fig. 1. Creep of zinc crystals under constant resolved shear stress. ●, experimental; —, according to equation 2

$$\frac{\tau_1}{\tau} = \left(\frac{1 - (l^2 \sin^2 \lambda)/l_1^2}{1 - \sin^2 \lambda}\right)^{1/2}, \quad . \quad . \quad (2)$$

where τ is the shear stress acting when the (initial) specimen length is l, τ_1 is the value associated with a (subsequent) length l_1, and λ is the initial angle between the glide direction and the axis of the applied tensile load. In the particular case where λ is small, approximately constant resolved shear stress can be obtained by a simple constant-loading method, as suggested and used by Andrade and Roscoe[2] on cadmium crystals; but in general a constant shear stress can only be maintained by relaxing the load as the specimen extends. We have been able to accomplish this by using a lever device the design of which is based on equation (2) but is otherwise similar to that used by Andrade and Chalmers[1] for maintaining constant tensile stress.

Several zinc crystals, in the form of wires, have been examined in this way, and the results have been expressed in terms of shear strain (on the glide planes in the glide direction) as a function of time of loading. Some of the results are given in Fig. 1. Since they are expressed in terms of shear strain, there can be no effect due to increasing gauge-length,

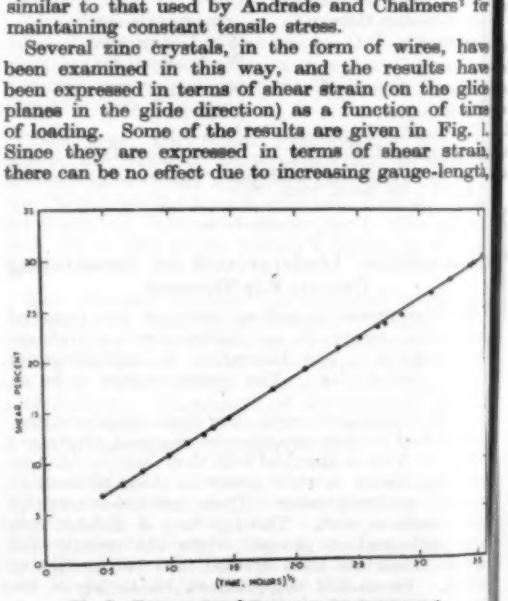

Fig. 2. Test of the β-flow law on specimen 1

so that the exponential term in equation (1) must be modified if this equation is to be applied to them. It is therefore proposed, on the basis of the two types of flow observed by Andrade, that his equation should in the present case be of the form

$$\gamma = \gamma_0 + \beta t^{1/3} + \varkappa t, \quad . \quad . \quad (3)$$

where γ is the total shear at time t and γ_0 is the instantaneous shear accompanying loading. The graph shows that this expression can be fitted closely to all the experimental results. Table 1 gives the equations of these γ—t curves with the details of the experiments. The fact that $\varkappa = 0$ for specimen 1 allows a more critical test of the β-flow law to be made in this case by examining the variation of γ with $t^{1/3}$; Fig. 2 shows that this is accurately linear.

Specimen No.	Temp. °C.	Resolved shear stress (gm./mm.²)	Initial angle between glide plane and wire axis	Initial angle between glide direction and wire axis	Coefficients in equation $\gamma=\gamma_0+\beta t^{1/3}+\varkappa t$ (γ in per cent, t in minutes)		
					γ_0	β	$\varkappa$
1	11·5	58	13°	14°	2·53	2·12	0·000
2	11·5	59	14°	27°	8·50	2·93	0·004
3	59·5	37	5°	12°	1·70	0·766	0·006
4	23·0	45	16°	19°	3·96	0·724	0·075
5	22·5	59	9°	28°	3·80	2·64	0·006
6	22·5	59	43°	44°	2·08	1·59	0·028

Further work is now proceeding with the object of elucidating the factors determining the coefficients in equation 3.

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Rheological Behaviour and Classification

The viscosity of a solution of aluminium stearate in petrol was determined by means of the falling sphere method. The results obtained are tabulated in Table 1.

Table 1

Temp. (° C.)	r (cm.)	r/R	$\frac{3}{2}\frac{v}{r}$ (sec.$^{-1}$)	$\dot{\sigma}_a$ (sec.$^{-1}$)	μ_F (poises)	Remarks
20	0·3175	0·1864	0·589	0·1062	828	Average of 3 results
20	0·2381	0·1405	0·411	0·0576	857	,,
20	0·1588	0·0935	0·313	0·0314	912	,,
20	0·1191	0·0700	0·279	0·0196	830	,,
					857	Average of 12 results
30	0·3175	0·1864	1·439	0·2584	340	Average of 3 results
30	0·2381	0·1405	1·136	0·1593	332	Average of 2 results
30	0·1588	0·0935	0·850	0·0777	338	Average of 3 results
30	0·1191	0·0700	0·669	0·0469	346	,,
					339·0	Average of 11 results

In Table 1, r is the radius of the steel ball and R the radius of the glass cylinder. The quantity $\left(\frac{3}{2}\frac{v}{r}\right)$ gives the maximum rate of shear occurring at the equatorial diameter of the falling sphere in an infinitely extended fluid, while $\dot{\sigma}_a$ gives the average rate of shear occurring in the body of the fluid bounded by the cylinder and the ball surface and by two planes touching the ball at the poles, as approximately calculated by Wood, Nissan and Garner[1]. The viscosity μ_F is that calculated by Faxen's equation taking the influence of the wall into account. The deviations between μ_F at 20° C. with balls of various sizes were of the same order as those obtained in the triplicate results with each size of ball. Thus, for this type of colloidal solution, the values for μ_F are substantially constant at 20° C. of the order of 860 p. and of 340 p. at 30° C. to ± 10 per cent under rates of shears of the order shown by $\dot{\sigma}_a$ and $\left(\frac{3}{2}\frac{v}{r}\right)$. For these conditions, therefore, in present systems of classifications this solution would be termed a 'Newtonian body'.

The viscosity of the same solution was determined by means of B.S.I. U-tubes (standardized by the National Physical Laboratory) at the same times as those for Table 1 and in the same thermostatic bath, which was known to be uniform in temperature both with respect to time and space within the bath to better than ± 0·05° C. Table 2 gives the results. In all experiments precautions were taken to eliminate vaporization of the solvent.

Table 2

Temp. (° C.)	Tube No.	$\dot{\sigma}_a$ (sec.$^{-1}$)	μ_T (poises)	Results in No. 3 / Results in No. 4	$\frac{\mu_T}{\mu_F}$
20	3	0·027	184	$\dot{\sigma}_a$ = 2·07	0·214
20	4	0·013	259	μ_T = 0·71	0·301
25	3	0·030	140	$\dot{\sigma}_a$ = 1·25	
25	4	0·024	150	μ_T = 0·96	
30	3	0·047	88	$\dot{\sigma}_a$ = 1·88	0·260
30	4	0·025	142	μ_T = 0·62	0·416

In Table 2, $\dot{\sigma}_a$ is the average rate of shear calculated from the dimensions of the tubes and the total time of flow. The viscosity μ_T is calculated from the constant of the tube and the density of the solution.

It is seen that although the average rates of shear are very low, the viscosity is smaller with the narrower tube, and this is most marked at 20° C. and 30° C., where the rates of shear are most widely different. According to the accepted nomenclature the system is 'non-Newtonian', and this is strongly supported by the marked difference in viscosity at 20° C. and 30° C. as determined by ball-drop and capillary methods.

To avoid such illogical conclusions, it would appear that rheological behaviour should be classified according to 'regimes' rather than 'ideal bodies'. Such a 'regime' classification would be in line with hydraulic classification of 'viscous', 'turbulent' and 'critical' regimes. There are other difficulties with present systems of classifications; for example, certain bodies show yield values under one condition of stress and not under another. Such complex systems could then be described by stating the conditions when they are in 'Newtonian regimes of flow', and the conditions when they are in 'non-Newtonian regimes'. In the above example, petrol solutions of aluminium stearate are normally considered as non-Newtonian, but appear to be in Newtonian regime in falling-sphere viscometers up to $\dot{\sigma}_a$ values of 0·2, whereas in tubes the Newtonian regime appears to break down at lower levels of rates of shear than even 0·02 sec.$^{-1}$.

The second point of interest is that, before detailed classifications of rheological systems be postulated, there is still a need for determining rheological constants in different apparatus on the same systems, to ensure that a true constant of the system is obtained. Thus in this example use of the ball viscometer would lead to the conclusion that the 860 p. viscosity of the solution at 20° C. was a constant of the liquid, whereas checking with the tube viscometer shows that 860 p. is, in fact, dependent on the apparatus as well as the liquid.

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[1] Wood, G. F., Nissan, A. H., and Garner, F. H., *J. Inst. Petrol.*, **33**, 71 (1946).

A Floating Magnet

By assuming that diamagnetic bodies are pushed out of a magnetic field, it may be shown that a diamagnetic particle attracted to a magnet by gravitational forces will take up a position in space in the equatorial plane of the straight magnet at a certain distance from the latter. The 'satellite' can vibrate elastically about the point of equilibrium, describing a certain curve. The period of vibration in the radial and meridional directions is close to the period of the Kepler rotation of a magnetically indifferent satellite about a body of the same mass. Several identical particles arrange themselves around the magnet. Such a combination of bodies is in the nature of a static planetary system as distinct from the Kepler dynamic planetary system.

However, systems thus formed can only be of small dimensions. The orbit of the outermost bodies can be no larger than several metres, and in the case of small magnetized iron meteorites amounts to several millimetres.

Computation shows that in space a straight magnet keeps at a certain distance from a large diamagnetic body. Thus a magnet 1 cm. long will take up a position at a distance of 1 cm. from the surface of a copper sphere about 20 m. in diameter. Diameters of 300 m. and 3,000 m. respectively would be necessary for bismuth and carbon spheres. To prevent a magnet falling on to a diamagnetic sphere the size of the earth, the sphere must consist of the strongest diamagnetic substance, or be a superconductor. In this case, however, it is sufficient that the superconductor is placed only under the magnet itself.

The approach of a magnet to the surface of a superconductive semispace is accompanied by the appearance of the magnetic image of this magnet within the superconductor. In the case of a common steel magnet, this may lead to demagnetization, while a ferro-nickel-aluminium steel magnet will be repelled from the horizontal surface of the semispace with such force that it will hang suspended ('float') over the latter without any support. Thus one of the cases of a static planetary system may be reproduced in the laboratory. The earth, screened by a superconductor in the neighbourhood of a magnet, repels the latter with the same force as it is attracted owing to universal gravitation. The accompanying photograph shows a magnet, 4 mm. × 4 mm. × 10 mm. in dimensions, floating above a concave lead

disk 40 mm. in diameter in a Dewar vessel over liquid helium.

The experimental test of these views was possible through the kindness of Prof. P. L. Kapitza, in the Institute of Physical Problems, Moscow.

The lower the coercive force of the magnet, the smaller the magnet itself must be. Carbon steel magnets, for example, can 'float' when they have the dimensions of 0·5 mm. × 9 mm. By scattering microscopically small magnets over the surface of a body, it is possible to reveal superconductive inclusions directly, since the magnetic particles will roll to the spots where there is no superconductivity.

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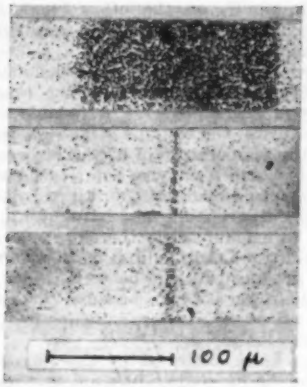
X-Ray Optics

Although optical reflexion and refraction of X-rays have been known for more than twenty years, they have so far found only one significant, although very important, application, namely, the spectroscopy of X-rays by means of optical gratings. But there is at least one other problem which should be solved by optical methods: the production of a finely focused beam which could be used to investigate both the action of X-rays on biological and other objects and the small-angle scattering from large molecules or fine powders.

I have therefore given attention to the problem of refocusing of X-rays passed through a fine slit by means of a curved reflector. It is known that all rays coming from one focal point of an ellipse are reunited at the second focal point. Further, it can be seen that the image formed by reflexion at a cylindrical elliptic surface of a source at one focus is a line parallel to the surface going through the second focus; therefore a line-object parallel to the surface and passing through one focus gives rise to a similar line-image going through the other focus. For the particular case of X-rays, reflexion occurs only at nearly glancing incidence, so that only a small part of a very elongated ellipse could be used. A perfect elliptic surface, however, can scarcely be realized, and neither slit nor photographic plate can be expected to be actually at the theoretical positions. I have therefore computed the aberrations which arise if the elliptic surface is replaced by a surface such as is formed by bending a rectangular beam, and also if slit and plate are displaced from their correct positions. It has been found that the surface



(*a*) PLATE 30 MM. FROM REFLECTOR, EXP. 90 SEC.; (*b*) 167 MM., EXP. 5 SEC.; (*c*) 174 MM., EXP. 5 SEC. COPPER ANTICATHODE, 15 kV. R.M.S., 10 mA., KODAK *B5* EMULSION

of a plate bent by a symmetrical pair of couples forms a reflector almost free from 'spherical' aberration in the region between the inner supports, and that the accuracy in setting required is not beyond one which could be reached by careful design and good workmanship. A 'camera' based on these computations provides for a separation of 35 cm. between slit and plate, with a reflector of gilded glass of an effective length of 3 cm. half-way between. The accompanying microphotographs are of photographic plates exposed in the converging beam emerging from the reflector, (*a*) at 30 mm. from the centre of the reflector, (*b*) at 167 mm., and (*c*) at 174 mm. It is seen that at 167 mm. an image only a few microns wide is obtained, the width on the plate being of the order of the range in the emulsion of copper *K* photo-electrons.

With a leverage of 15 cm., interferences arising from spacings of 0·005 mm. should thus be resolved. It was noticed, however, that for very much prolonged exposures such as would be required for their detection, the focal line develops rather extended wings, which may be due to a number of causes. For example, it was observed that the mirror develops a tarnished appearance, probably due to deposition of particles from the heavily ionized atmosphere in front of it. Experiments are in progress in order to find the cause of this small-angle scattering, and a remedy for it.

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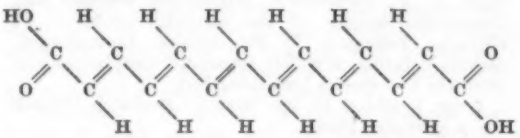
Corticrocin, a Mycorrhiza Pigment

FROM the yellow mycorrhiza fungus *Corticium croceum*, a pigment has been isolated for which the name 'corticrocin' is proposed. *Corticium croceum* is a symbiont on the roots of *Pinus silvestris*, *Picea excelsa*, *Vaccinium vitis idæa* and other plants. The symbiosis is especially common when the plants grow on a poor, acid, sandy soil or on raw humus.

Corticrocin is extremely sparingly soluble in most organic solvents, but may be crystallized from pyridine, forming long yellow needles containing pyridine. This is easily removed by washing with ether, acetone or alcohol or by evaporation over concentrated sulphuric acid. It forms orange-red needles which are soluble in dilute alkali and decompose at about 310°. Very small samples may be sublimed in a high vacuum. In sealed, evacuated capillary tubes the substance starts to sublime at about 270–280°. The composition agrees with the formula $C_{14}H_{14}O_4$. With diazomethane a dimethyl derivative is obtained, forming golden yellow, glistening plates or orange needles m.p. 230–232°, which have the composition $C_{14}H_{12}O_4(OCH_3)_2$. This derivative is sufficiently soluble in camphor to permit the determination of the molecular weight (found 284 and 305; calc. 274). On catalytic hydrogenation six molecules of hydrogen are absorbed and the dimethyl ester of *n*-tetradecane dicarboxylic acid $(CH_2)_{12}(COOCH_3)_2$, m.p. 44–45°, is formed. Hydrolysis of this acid affords *n*-tetradecanedicarboxylic acid, m.p. 125–126°. The melting points were not depressed on admixture with the appropriate authentic specimens.

Consequently corticrocin is very probably tetradecahexa-enedicarboxylic acid. This conclusion is supported by the fact that all the physical properties of the substance, such as ultra-violet absorption, colour, solubility and melting point of the acid and the ester fit very well into the series of polyene dicarboxylic acids studied by R. Kuhn *et al.* They prepared all the dicarboxylic acids up to dodecapentaenedicarboxylic acid, the next lower analogue of corticrocin. It is probable that the molecule has the trans-configuration :



Corticrocin is the first *n*-polyenoid diacid found in Nature. Its nearest analogues among the true carotenoids are crocetin and *nor*-bixin.

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Production of Citrinin by Five Species of *Penicillium*

IN the course of a routine examination of species of *Penicillium* for antibacterial activity, the following were shown to produce citrinin : *P. lividum* Westling ; *P. phæo-janthinellum* Biourge ; *P. implicatum* Biourge ; *P. chrzaszczi* Zaleski ; *P. citreo-sulfuratum* Biourge.

All five cultures were supplied by Prof. J. Westerdijk, of the Centraalbureau voor Schimmelcultures, Baarn. Another strain of *P. lividum* (No. 6522, National Collection of Type Cultures, London) was tested and found inactive. Another strain of *P. implicatum* (N.C.T.C. No. 6524) and one of *P. chrzaszczi* (N.C.T.C. No. 6611), previously reported to produce antibacterial activity[1], were also found to produce citrinin.

The first three species belong to the section Stricta of the division Monoverticillata, and so are fairly closely related. *P. citreo-sulfuratum* is placed by Thom[2] in the section Stricta of the division Monoverticillata. Westerdijk[3], however, lists it as synonymous with *P. chrzaszczi* Zaleski. *P. chrzaszczi* has

been placed in the section Lanata divaricata of the division Asymmetrica.

On layers of medium 2 cm. deep incubated at 25° C., *P. lividum* produced maximum antibacterial activity after sixteen days in Sabouraud medium, *P. phæo-janthinellum* after twelve days in modified Czapek-Dox medium, *P. implicatum* after five days in potato-dextrose medium, *P. chrzaszczi* after twelve days in Sabouraud medium, and *P. citreo-sulfuratum* after twenty-two days in glucose Sabouraud medium. Maximum activity was in each case maintained for several days.

The inhibitory substance could often be precipitated directly in micro-crystalline form by acidification of the crude culture medium. In all cases it could be extracted into amyl acetate from acidified medium and re-extracted into a smaller volume of buffer or water at *p*H 8·0, from which it could then be precipitated by acidification. The N.C.T.C. strains of *P. chrzaszczi* and *P. implicatum* did not produce enough citrinin to show antibacterial activity by the cylinder-plate method of assay until the culture filtrate had been concentrated by extraction in this way. After twice recrystallizing from alcohol, bright yellow crystals were obtained, melting at 171–172° C. (uncorr.). In each case colour reactions of the substance and its oxidation product with ferric chloride, silver nitrate and lead acetate conformed to those described for citrinin, and its mixed melting point with authentic citrinin confirmed its identity.

Citrinin has been isolated from the metabolism fluid of *P. citrinum*[4,5], *Aspergillus terreus*[6] and *Aspergillus* species of the candidus group[7]. *P. citrinum*, belonging to the division Asymmetrica, section Velutina, is widely separated morphologically from the five species here described.

I am indebted to the Medical Research Council for a personal grant.

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June 10.

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Biochemistry of *Escherichia coli* and the Production of Penicillinase

Bacterium coli, inoculated in broth, metabolizes the culture medium producing alkalinization, bringing the *p*H to 8·5 and more. These are the standard conditions we used to obtain penicillinase[1].

To obtain purer solutions of the enzyme, we carried out experiments with *coli* cultures in a synthetic medium in which the source of nitrogen is inorganic and in which glucose was the source of carbohydrates. In these conditions *B. coli* metabolism is totally different from that in broth, the medium becoming acid and the *p*H going down to 5. A first observation on superficial lines did not disclose any penicillinase in such media. Concerning the enzymatic ensemble of *B. coli*, Gale[2] has shown that aminoacidodecarboxylase is produced only if the *coli* are living in an acid medium; if, on the other hand, the micro-organism exists in an alkaline medium, decarboxylase is not found, but deaminase.

Of course, we made sure that penicillinase is stable at the different *p*H and within the range of time taken for experiments. We were able to establish that up to *p*H 4, the enzyme is stable even for a few weeks at the temperature of 37°. This is so, not only with partly purified enzyme solutions, but also with cultures sterilized by filtering or killed by the addition of 0·25 per cent phenol and brought up to the *p*H required. Penicillinase is therefore not inactivated by the acidity of the medium as it is formed; it is not even produced by the bacteria. The production of penicillinase is possible because *B. coli* is able to bring the *p*H of the medium in which it lives towards the acid or alkaline side.

This has been confirmed by the following experiments. As we have already seen, in common broth medium the *coli* alkalinizes the medium and produces penicillinase; if 0·4 per cent glucose is added instead, the *coli* acidifies the medium and does not produce penicillinase. If at the same time a few grams of precipitated chalk are put at the bottom of the medium, the *coli* alkalinize the medium and produce penicillinase. On the other hand, analogous tests in a synthetic medium (Myrbäck) containing 0·4 per cent of glucose show that the *coli* develop and acidify the medium without producing penicillinase if chalk is included. As a counter test, in broth as well as in a synthetic medium, we were able to make the following observations. If the culture in a glucose medium (which either in broth or in synthetic medium normally tends to become acid) is neutralized daily with sodium hydroxide, it is found that, after about a week, there being no more fermentable sugar present, the *p*H remains at 7. Up to this point, penicillinase could not be detected, but from then the *p*H goes up towards the alkaline and formation of penicillinase starts. Control cultures, not neutralized, always remain at *p*H 5 even after a month, and do not show the presence of penicillinase. On the other hand, cultures in broth without glucose and, therefore, alkaline and active for penicillinase, become acid after an addition of a sterile glucose solution, but they do not lose the penicillinase activity shown previously.

The fact that the presence of chalk allows the culture to reach *p*H 8–8·5 showed by itself that in the case of *B. coli* the chalk was not merely acting as a buffer. Indeed, when calcium phosphate replaced chalk as the solid buffering phase, no alkalinization at all was found, but the culture registers a *p*H about 5, and consequently no penicillinase is detected. Such observations made us doubt whether the presence of carbon dioxide is of any fundamental importance. The hypothesis is furthermore supported by the observation that, in the presence of chalk, development of the culture starts with acidification with a consequent development of bubbles of carbon dioxide, and only after about two days of incubation does the *p*H go up again to reach in 8–10 days the value of 8–8·5.

Carbon dioxide was bubbled to saturation through a portion of an ordinary synthetic medium with glucose immediately after sterilization in an autoclave and cooling; the *p*H goes down to 5·5–6 and is then made neutral again by adding sodium hydroxide. In this way we prepared controls not containing carbon dioxide. Development of *B. coli* takes place normally with acidification of the medium in these

controls (without carbon dioxide) and with alkalinization of the cultures containing carbon dioxide. As usual, penicillinase is present only in the cultures that become alkaline.

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A Terpene-type Essential Oil from a Fern (*Pæsia scaberula*)

IN contrast with the higher order of plants (Spermophyta), essential oils are rare in all the lower orders (Thallophyta, Bryophyta and Pteridophyta)[1]. There are only four records among the Pteridophyta, and in none of these is there any definite evidence for the presence of terpenes or their derivatives.

From the scented fern, *Pæsia scaberula*, endemic to New Zealand, we have now obtained an essential oil of terpenic nature from which a sesquiterpene alcohol, $C_{15}H_{24}O$, and the paraffin, *n*-heptacosane, have been isolated, while the presence of oxygenated terpenes and sesquiterpenes is also indicated.

The deep-red oil obtained in 0·05 per cent yield by steam distillation of the fronds collected in the autumn had d_4^{22} 0·948, n_D^{25} 1·4990, and deposited a small quantity of crystalline paraffin on standing. Distillation of the small quantity available (10 gm.) through a short Vigreux column gave the following fractions:

Fraction	B.P./5 mm.	d_4^{25}	n_D^{25}	Weight (gm.)
1	63–85	0·907	1·4740	0·55
2	87–100	0·905	1·4800	1·09
3	100–115	0·910	1·4928	2·45
4	115–130	0·925	1·5002	1·01
5	130–154	0·975	1·5078	3·30
6	154–200/1 mm.	Partly solid		0·78
7	Residue, a dark-red gum.			

All fractions gave strong colorations with tetranitromethane, antimony trichloride and concentrated sulphuric acid, while their physical properties are consistent with those of terpene derivatives.

The liquid 3:5-dinitrobenzoic ester obtained from fraction 5 by treatment of the reactants in picoline solution was saponified and the product fractionally steam-distilled. The first portion consisted of a mixture of a sesquiterpene alcohol and the hydrocarbon derived from it by dehydration, while the second much more viscous fraction had d_4^{25} 0·982, n_D^{25} 1·517, *M* (Reiche's apparatus with acetone) 218 (found: C, 82·0, 82·0; H, 11·5, 11·3. $C_{15}H_{24}O$ requires C, 81·8; H, 10·9 per cent; *M*, 220). The analytical data, the molecular weight and the molecular refraction, 67·8, agree with those of a dicyclic sesquiterpene alcohol ($C_{15}H_{24}O|\overline{=}_3$ requires 67·7). This fraction gave an immediate violet colour passing to intense blue when bromine vapour was added to its solution in glacial acetic acid.

The small amount (*c.* 250 mgm.) of solid separating from fraction 6 was repeatedly purified by treatment with hot concentrated sulphuric acid and crystallization from alcohol and then had m.p. 57–59° (found: C, 85·3; H, 14·9. $C_{27}H_{56}$ requires C, 85·3, H, 14·7 per cent). The hydrocarbon thus agrees with *n*-heptacosane (lit. m.p. 59·5°); but since higher and lower melting fractions were obtained during the purification, it is probably mixed with the odd, numbered paraffins, $C_{25}H_{52}$ and $C_{29}H_{60}$, as Chibnall-Piper and collaborators[2] have found for other plant waxes.

A more complete examination will be made when further supplies are available.

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Lipochromes in the Ova of *Pila*

MANY species of the South American gastropod *Pila* lay highly coloured egg masses, usually red, but in some cases green. In the case of *Pila glauca* Linn., an Argentine form, the pigment is readily extracted by crushing either the eggs or the bright red 'uterine' gland with water. These extracts are stable to weak acids and alkalis, unstable to strong acids, and decolorized by heating, with partial reversal on cooling. The pigment is wholly precipitated by saturated ammonium sulphate.

Treatment with acetone or alcohol changes the colour to deep orange, and the resulting solution shows carotenoid behaviour. On chromatography it proved to be a mixture of at least six carotenoid bodies covering the whole elution-range. We found some indications that they vary from individual to individual. The exact composition of the extract is probably determined by the dietetic intake of lipochrome bodies. On partition between 90 per cent methanol and petrol ether, most of the pigments appear in the hypophasic fraction.

Early embryos were not seen, but at the late proveliger stage there is intense staining of the yolk-cells of the visceral hump with the red material; on denaturing with alcohol it is broken up into diffuse orange granules. There is a pigmented granule at the base of each velar cilium. The intact pigment in formol-fixed embryos shows a single spectral absorption band at 550—the denatured pigment is spectrally unhomogeneous. The liver of the newly born larvæ is intensely pigmented, but this pigmentation is obscured soon after birth when the organ becomes black, and adult livers contain a mixture of carotenes, enterochlorophylls and bile pigments.

Judging by available records, coloured eggs are confined to New World *Pila*, which lay eggs out of water, and are not produced by the Indian forms, which bury the egg mass. The pigment is present in the vitellus, which stains paper permanently. It seems to be a lipochrome-protein complex, which is broken up by denaturing agents and organic solvents to give free carotenoids. It is perhaps surprising that so little notice has been taken in the anatomical literature of the very intense colour of the female 'uterus' or yolk-gland—this is a better and more

manageable source of pigment than the eggs. Although such protein complexes are widely distributed among Crustacea, they do not seem to be common in molluscan eggs. It is hoped to pursue the embryology of the pigment, which gives an excellent vital-staining effect; material in formol would be welcome, owing to the difficulty of obtaining supplies of *Pila* in Britain.

Thanks are due to Mr. Bushby, of the London Zoo, for his generosity in providing material, and to Mr. E. M. Jope and Dr. Hans Hoch, of the London Hospital Research Laboratory, for their advice and help in identifying the pigments.

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Effect of *l*(+)Glutamic Acid in Hypoglycæmia

OXIDATION of *l*(+)glutamic acid by brain tissue was first demonstrated *in vitro* by Quastel and Wheatley[1]. This work was developed by Krebs[2] with reference to the function of glutamin and glutaminase. Weil-Malherbe[3] suggested that *l*(+)glutamic acid fulfils a specific function in relation to carbohydrate metabolism in cerebral tissue. Latterly, Waelsch and his collaborators[4] observed that the oral administration of *dl*-glutamic acid hydrochloride reduced the number of petit mal attacks in epileptics while it was without effect upon major seizures. Zimmerman *et al.*[5], confirming these observations, have claimed a favourable influence of the orally administered *l*(+)glutamic acid upon the intelligence of defective children.

This communication is a preliminary report of a series of observations designed to reveal whether *l*(+)glutamic acid could, *in vivo*, replace glucose as a substrate for brain metabolism. The subjects of the experiment were otherwise healthy schizophrenics undergoing Sakl's insulin coma treatment. The preparation of *l*(+)glutamic acid used was a solution prepared by the neutralization of *l*(+)glutamic acid hydrochloride with sodium hydroxide and adjusted to a *p*H of 7·2. This preparation contained the equivalent of 26 gm./100 ml. of *l*(+)glutamic acid and between 8 and 9 gm./100 ml. of sodium chloride. Sterilization was effected by filtration through a Ford 'Sterimat' grade *SB*.

Each subject was allowed to enter hypoglycæmic coma in the usual way and was thereafter left undisturbed for a period of fifteen minutes. After a preliminary blood-glucose determination, 80 ml. of solution (20 gm. *l*(+)glutamic acid) was injected intravenously over a period of two minutes. A series of blood-glucose determinations was made while the subject was observed for signs of returning consciousness.

In twelve out of fourteen cases, after a period which varied between five and ten minutes, the subjects became sufficiently conscious to answer questions and to drink of their own accord. The two remaining subjects showed signs of decreasing depth of coma without being fully awake. During the period of awakening the blood glucose rose from 10 mgm. (± 2)/100 ml. to 30 mgm. (± 4)/100 ml.

Using the same subjects, control observations were made after (1) the injection of a similar quantity of a sodium chloride solution containing 9 gm./100 ml.; and (2) the administration of 200 gm. of sucrose by nasal tube into the stomach.

In the first series of controls the injection of sodium chloride solution was without effect upon either consciousness or blood-glucose level. In the second series of controls consciousness was restored at a blood-glucose level of 52 (±3) mgm./100 ml.

It will be seen that, after the intravenous injection of *l*(+)glutamic acid, consciousness is restored at a considerably lower level of blood glucose than when glucose or sucrose alone is employed. We have previously shown[6] that a blood-glucose level of 50 mgm./100 ml. is necessary before sufficient glucose is available to the cortical cell for the restoration of consciousness, and it is unlikely that sufficient glucose would be so available at the levels of blood glucose obtained after the injection of *l*(+)glutamic acid. It therefore seems probable that the *l*(+)glutamic acid was acting as a substrate for the metabolism of the brain cells.

The problem arises of how to explain the rise in blood glucose after injection of *l*(+)glutamic acid. There would seem to be two possibilities: it may be synthesized in the body from the glutamic acid injected, or it may be remobilized from the reserves of glycogen. This problem is being investigated further.

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Use of Filter Paper Pellets in the Spectrochemical Analysis of Solutions

THE Ramage method[1] for the spectrochemical analysis of solutions has been developed by other workers[2]. In this method, filter paper is impregnated with the solution and is introduced into the flame or arc in the form of a roll or strip. Mechanical devices have been designed to ensure the steady combustion of the sample[2].

We have found that if filter paper (quantitative, 'ashless') is disintegrated with concentrated hydrochloric acid and well washed, the resulting pulp can be easily compressed into small cylindrical pellets which serve as a convenient supporting medium for solutions that are to be analysed by arc methods. The pellets, after forming, are dried in an oven and then impregnated with a measured volume of the solution by touching the pellet with the tip of a micro-pipette. The impregnated pellets are dried again, and 'arced' in the crater of a carbon or graphite arc.

Our original pellets did not burn satisfactorily; but this difficulty was overcome by adding dilute potassium nitrate solution to the original pulp. If potassium is to be determined analytically, another oxidizing agent can be substituted for potassium nitrate.

At present, we are using pellets approximately 0·5 cm. in diameter and 0·2 cm. long, which will absorb 0·03 ml. of solution.

The use of these pellets has some obvious advantages for the spectrochemical analysis of solutions. The pellets are easily prepared, dried and impregnated in large numbers. When dry, they can be handled with forceps with no danger of loss or contamination. No complex apparatus is needed to introduce them into the arc. It is easy to impregnate them with 'internal standard' solutions from a micro-pipette, and large numbers of 'standard' pellets can be prepared at one time and stored in bottles for use at any future date. Different sets of standard pellets can be dyed with characteristic colours to avoid confusion. A disadvantage is the small volume of solution they contain, although it is convenient to use pellets considerably larger than the size mentioned above.

Details of the sensitivity and reproducibility of the method in selected cases will be published elsewhere.

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Frequencies of Sex-Linked Red-Green Colour Vision Defects

In a research carried out during the last five years on subjects in the west of Scotland, with an apparatus which efficiently discriminates between major (sex-linked) red-green defectives and ordinary colour-weak individuals, 7·8 per cent of male and 0·65 per cent of female sex-linked defectives were found in 464 males and 460 females. This corresponds well with the results of researches in which the Ishihara Test was used[1,2,3]. The expected frequency of female defectives would be 0·61 per cent, with 7·8 per cent of males in the population. The observed frequency of 0·65 per cent is not statistically different from this figure, and it suggests that there is little truth in the common belief that there are more colour-blind women in the population than would be expected. The extra ones are heterozygotes, some of whom are doubtful passes on the Ishihara test.

	Deuteranopes	Protanopes	Green anomalous	Red anomalous	Total
Men	44	29	22	6	101
Women	4	5	4	1	14

Among 101 men and 14 women red-green major defectives, the proportions of different types found are shown in the table. The chance proportions of women are distorted because several women protanopes came from the same family. In general, protanopes tend to be more often extreme than moderate, while deuteranopes tend to be moderate more often than extreme. The degree of defect is hereditary. Anomalous subjects show almost as little variability as normal individuals. In two thirds of the red anomalous subjects the red end of the spectrum is not darkened or shortened, a condition inexplicable on the Young–Helmholtz theory. These subjects would be classed as 'green-blind' by the Ishihara test.

If we split up the 7·8 per cent of male red-green defectives, it would consist of about 3·4 per cent of deuteranopes, 2·2 per cent of protanopes, 1·7 per cent of green and 0·5 per cent of red anomalous. Of these, many protanopes and deuteranopes would be extreme enough to fail on the Holmgren wools test, making up the 3 or 4 per cent of red-green blind subjects reported by earlier workers[4], while the entire 7·8 per cent would fail on the Ishihara test, without clear discrimination between anomalous and protanopes or deuteranopes. The doubtful failures on this test are the slight deuteranopes and also some red-green weak subjects who are probably not sex-linked defectives. The true anomalous are generally outright failures.

The study of a number of families in which there are colour-blind women strongly suggests that the four (or five) types of red-green sex-linked defects may be multiple allelomorphs. The green anomalous condition would appear to be dominant to that of the deuteranope, though all four (or five) types are slightly incomplete recessives to the normal condition. The order of dominance of these types among themselves has not been determined, owing to lack of data.

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Oviparity in *Littorina saxatilis* (Olivi)

It has always been believed in the past that all the sub-species and varieties ascribed to *Littorina saxatilis* (Olivi)[1] are viviparous. Contrary to this, it has now been observed that some of these reproduce very much like *L. littoralis* (L.) by means of gelatinous egg masses[2].

While working on *L. saxatilis* at Cullercoats, I found, in November 1946, a number of small, irregular, transparent, gelatinous masses of gastropod eggs in rock-crevices at high-tide level amid clusters of this species. As the various stages of development showed Littorinid characters, they were at first passed off as belonging to *L. littoralis*, the only British species of *Littorina* so far known to lay such egg masses[3]. But soon this became very doubtful on account of their repeated and exclusive occurrence at levels and regions far separated from those occupied by that species. They also differed from the egg masses of *L. littoralis* in having a massive and irregular shape and in the eggs themselves being rosy pink instead of "yellowish to water-clear"[2,3].

Detailed field observations and marking experiments were therefore conducted, and these clearly indicated that the egg masses belonged to some of the individuals of *L. saxatilis* itself. Qualitative analysis of some of the clusters surrounding the egg masses showed that, while (*a*) some of the individuals were of the viviparous *rudis* type, (*b*) most of them were distinct from this in being smaller in size, and in having a larger operculum, a thinner shell, and a shorter spire with a rather blunt apex. In shell

sculpture, however, the latter group showed great variation, ranging from completely smooth and partially ridged conditions to well-developed widely spaced ridges of the *jugosa* type[1]. They were thus found to agree very well, both in shell features and habitat, with the descriptions given by Alder[4] for *L. rudissima* Bean, and by Forbes and Hanley[5] for *L. patula* Jeffreys. Dissection of more than two hundred adult females of this category showed in each case, irrespective of the sculpture of the shell, not only the absence of shelled embryos inside but also the presence of "Eiweissdrüse", "Kapseldrüse" and "Gallertdrüse", closely comparable with those seen in *L. littoralis*[6]. Several individuals of this kind were then reared in the laboratory, and some were found to lay egg masses there as well.

It seems probable, therefore, that these thin-shelled forms should be regarded as quite distinct from the rest of the sub-species and varieties of *L. saxatilis*. Any suggestion of their being physiologically different but younger stages of the viviparous *rudis* forms must be ruled out, as the corresponding sizes of the latter not only present the shell features quite clearly, but also frequently contain shelled embryos. That classification of these forms based solely on shell sculpture is not indicative of actual relationships is also obvious. Further work is in progress, and a full account of the systematics and biology of *L. saxatilis* will be published in due course.

My thanks are due to Prof. A. D. Hobson, under whose supervision this work is being carried out.

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Survey of Mineral Deficiencies on Tillage Land

During the last few years a field technique has been developed at Long Ashton for determining the nutrient condition of crops by the use of two complementary methods: (*a*) 'visual diagnosis'[1] and (*b*) 'tissue-tests'[2,3]. Technique (*a*) depends upon the appearance of specific symptoms associated with mineral deficiencies, and (*b*) depends upon the use in the field of rapid colorimetric and turbidity tests for estimating the mineral status of the growing crop.

In order to make a survey of nutritional deficiencies in crops, it is possible to apply the above technique to a random sample of fields[4] within any particular specified unit of land area, and as a result to obtain statistics of practical value to the soil chemist and agriculturist in relation to the beneficial or deleterious use of lime and fertilizers. In Great Britain the county is a convenient land unit for a season's work, as has been shown by two surveys carried out in Herefordshire during 1945 and in Somerset during 1946. In each of these surveys a random sample of farms was taken representing 2 per cent of all holdings of 10 or more acres. Each farm was visited two to three times during the season (May–October), and the following crops were inspected: cereals, beans, potatoes, sugar beet, roots and kale. The evaluation of crop vigour and yields, which is based on empirical standards for each crop, was done visually.

The relationship between the growing condition of a crop and deficiencies showed mainly that nitrogen deficiency occurred in most crops, and more so in those where the level of husbandry was low; phosphate deficiency was also prevalent in most crops, but particularly so in cereals; potash deficiency was almost confined to potatoes but occurred in some mangolds, whereas calcium deficiency was found only in roots. Trace-element deficiencies were confined to boron, which affected two root crops, sugar beet and mangolds.

The overall statistics which are given in the table show the general incidence of deficiencies on the tillage land growing the crops mentioned.

Incidence of deficiencies on tillage land in Hereford and Somerset

County	Total crop acreage (thousand acres)	N	P	K	Ca	Mn	B
		%	%	%	%	%	%
Hereford 1945	136	10·0	20·0	1·0	0·5	0·0	0·3
Somerset 1946	167	18·0	19·0	1·0	0·0	0·0	0·0

It will be seen from the table that the chief deficiencies are of nitrogen and phosphorus. The unusually high incidence (18 per cent) of nitrogen deficiency in Somerset during 1946 was probably due to the wet season. The agreement between the high phosphorus figures (20 per cent) in both counties indicates similar husbandry practices. In contrast, the incidence of potash deficiency is low, but likewise is the same in both counties. Calcium deficiency or the problems associated with the acidity complex record a negligible figure for Hereford (0·5 per cent) and a zero value for Somerset. The incidence of trace-element deficiencies was low and concerned only boron, which sometimes occurred after liming on the Old Red Sandstone and Silurian soils found in Hereford.

The figures indicate the general problem of crop nutrition in two West Country counties. It is likely that surveys in the east of Britain, where climatic and soils conditions are different, would reveal a somewhat changed picture.

The results of this work suggest that a more rational use of fertilizers would involve the increased use of nitrogen for all crops and of phosphorus for cereal growing; increased dressings of potash to potatoes only; the use of lime only where soil tests show a definite need, and avoidance of over-liming, which on certain soils induces boron deficiency.

A detailed account of the methods and results of these surveys will be published later. The work was carried out under the special scheme for the investigation of mineral deficiencies of crops organised and financed by the Agricultural Research Council. The assistance of the Statistical Department at Rothamsted is gratefully acknowledged.

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Number of *S*-Alleles in a Population

DATA collected by the late R. D. Williams on self-incompatibility in two clover varieties are presented in the current issue of the *Journal of Genetics*[1]. A comparison was made between all the alleles in a sample of each variety, involving about a thousand separate crosses.

The interest lies in the number of *S*-alleles occurring in each sample. It was found that 25 plants from one variety had between them 43 distinct alleles out of a possible maximum of 50 (2 per plant). In the second variety, 22 plants had 41 distinct alleles out of a possible 44. Thus seven alleles in the first sample and three in the second occurred twice. It is possible, however, to deduce further information from the data. One can estimate in the following way the minimum number of different alleles in the populations from which the samples were drawn.

For a similar problem[2], Sewall Wright has shown that if a population has n different kinds, the proportion of any one kind being p, ($\Sigma p = 1$), the probability that a random pair will be of the same kind is given by $1/n + n\sigma_p^2$, where σ_p^2 is the variance of p.

It is obvious from Williams' data that the variance in frequency of *S*-alleles cannot be high since no allele was found more than twice. Let us assume for the moment that all the alleles are of equal frequency. Then the probability of a random pair being identical is $1/n$.

According to the workings of the incompatibility mechanism, the two alleles in one plant must be different. Not only does this mean that the comparison between alleles from the same parent is not random but, if an allele of one plant is found to be identical with the first allele of another, then it cannot be identical with the second. The only truly random comparison is that between plants, rather than between single alleles. It can easily be seen that the chances of finding an allele common to a random pair of plants is four times that of finding an identical pair of alleles in a random sample.

Thus, as an approximation, it can be taken that the probability of finding an allele common to a pair of plants in Williams' sample is $4/n$. In the first sample there are 300 possible pairs of 25 plants, of which 7 have an allele in common. The error of estimation of the probability is high but can be estimated[3]. In the second sample there are 3 pairs out of 231 which have an allele in common.

First variety	$\frac{4}{n} = \frac{7}{300}$	with the 5% limits of	$\frac{2{\cdot}8}{300}$ and $\frac{14{\cdot}4}{300}$
	$n = 171$	„ „ „ „	„ 429 and 83
Second variety	$\frac{4}{n} = \frac{3}{231}$	„ „ „ „	„ $\frac{0{\cdot}62}{231}$ and $\frac{8{\cdot}8}{231}$
	$n = 308$	„ „ „ „	„ 1490 and 105

The estimates for the two varieties do not differ significantly. We are therefore justified in pooling the results to obtain a more accurate estimate.

For both varieties $n = 212$ with 5 per cent limits of 442 and 115. This is an estimate of the number of alleles in *each* variety if both had the same number.

The error due to the variance of p (see above) is unlikely to be large compared to that due to sample size.

The method would be more informative if the total number of alleles was less. Though without great precision, the present estimate is of interest since it pertains to non-pedigree commercial varieties of clover which must be similar in genetical structure to natural populations.

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July 8.

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A Tri-colour (Mosaic) Shorthorn Cow

RECORDS of colour mosaicism in the Mammalia are rare[1] and among cattle especially so, there being only four in the literature[2]. Moreover, in pedigree herds such anomalies would not be recorded in the herd books. In view of this, the following case of a pedigree Dairy Shorthorn cow is of interest. The animal, Gwersyllt Lucy 17th, had a patch of black hair, about 14 in. × 12 in., on the shoulder extending on to the neck. The rest of the coat was a typical roan colour. The sire of G. Lucy 17th was a pure-bred Shorthorn bull, Iford Lord Laurel 13th, 258054 (the number is the registration number in Coates' Shorthorn Herd-book, from which the pedigree may be obtained; this applies also to the two bulls noted below). On the dam's side, the pedigree extends back for three generations to a non-pedigree red-and-white Shorthorn cow. This cow has not been seen, nor was her daughter, but the owner states that no trace of black could be observed in either. I have myself examined the grand-daughter, the mother of G. Lucy 17th; and she was a typical red-and-white Shorthorn with no black on the coat. The sires on the dam's side were all pure-bred Shorthorns (*vide* Iford Royal Waterloo 26th, 231016, the maternal grand-sire of G. Lucy 17th). The tri-colour has given one offspring, a white male, by Plaspower Tamini, 239473, white.

Black hair is not normally present in Shorthorn cattle, the colours being red, red-and-white, roan and white. Genetically, all Shorthorns are considered to be homozygous for red, and red animals to be *bbnn*, white *bbNN* and roan *bbNn* (where *B* gives the black of black breeds and *b* is 'not-black'; *N* inhibits the formation of pigment, *n* allowing pigment to develop; white spotting is recessive and inherited separately)[2,3]. It has been suggested that all cattle are homozygous for black[4], with therefore black-pigment inhibitors present in red breeds. This is doubtful, at least so far as Shorthorns are concerned[3]. In any event, a patch of black hair is unexpected on any theory dealing with the normal colour inheritance in Shorthorns. There was no abnormality in the black hair itself of G. Lucy 17th; microscopic examination showed it to be similar to that of black breeds of cattle, and the red and white hairs to those of typical Shorthorns.

Two of the four cases of colour mosaics in cattle are similar to the one described here—a pure-bred Hereford with a patch of black hair on the neck, and a red-and-white 'Schlesischen Landvieh' with a black area on the left shoulder—and Ibsen regards these as examples of somatic mutation[3]. The same explanation would apply to G. Lucy 17th, it being necessary to consider that, in a somatic cell ancestral to the black patch, *b* mutated to *B*. This presumes a dominant mutation, an explanation rarely invoked, as the majority of mammalian colour mosaics can

be explained by supposing somatic non-disjunction to have occurred[1]. Little is known of the chemistry of mammalian pigments, but if the formation of red and black in cattle represents different levels of the same process, it may be that the anomalous condition shown by G. Lucy 17th was not chromosomal in origin, and that the explanation might lie in the influence of oxidation-reduction potentials, the work of Figge[5] being very suggestive in this respect.

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July 7.

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Risk of Contamination in Experimental Carcinogenesis

The fluorescence of polycyclic aromatic hydrocarbons has afforded an extremely useful guide in most of the chemical and biological studies concerned with them. While making use of this property in examining various materials for possible traces of known carcinogens, several observations were made which seem worthy of note when grouped together.

When working in laboratories where both chemical and biological experiments are being carried out with various carcinogenic materials, one is constantly on guard against the risk of contamination. Indeed, attention has already been directed to this point by Earle[1] who, while conducting experiments on carcinogenesis in tissue cultures, concluded that alterations in the control cultures might possibly be due to a trace contamination of methylcholanthrene, and more recently by Hieger[2] in connexion with the risk presented by contamination from the city atmosphere. In these laboratories care has always been exercised to eliminate errors from this source, and all apparatus used in the course of an experiment has been hitherto examined under ultra-violet rays on the assumption that any traces of carcinogenic hydrocarbon would be detected, since most of these compounds also fluoresce in the solid state.

Observing this precaution and exposing solvents to the surrounding atmosphere as little as possible, an extract was made of toasted breadcrumbs, which on concentration and chromatographic analysis yielded a blue-violet fluorescent solution having a spectrum identical with that of 3 : 4-benzpyrene. A similar procedure was adopted with an extract of untoasted breadcrumbs to provide a control, and although a bluish-fluorescent solution was obtained from this, the fluorescent spectrum of this fraction showed no band structure even after repeated chromatography. At this juncture, some results were published by van Schelven[3] claiming tumour induction in mice with benzene extracts of blackened bread and other burnt foodstuffs. An extract was therefore made of the black crusts of several loaves, and again a fraction was obtained which had a fluorescence spectrum corresponding with that of 3 : 4-benzpyrene. However, in the control of this experiment, which consisted merely of 500 ml. of benzene concentrated to 5 ml., a fraction was also obtained which had the characteristic 3 : 4-benzpyrene spectrum.

Obviously the precautions being taken were inadequate to remove the risk of contamination. Preliminary investigations showed that most commercially available solvents possess a slight fluorescence, which becomes more evident, however, on the concentration of a large volume of solvent to small bulk; and that most apparatus on remaining in the laboratory atmosphere for a short time, even after cleaning with chromic acid, acquires a film of material which remains undetected in daylight and under the ultra-violet lamp, but which becomes strikingly apparent on the addition of a small quantity of benzene followed by examination under the ultra-violet lamp. No spectrographic evidence has been obtained suggesting the presence of traces of benzpyrene in the solvents, and while the fluorescence from this source is confusing when traces of fluorescent material are being sought, the most likely source of contamination from benzpyrene is the laboratory atmosphere.

These findings are significant when it is realized that a great deal of research has been and is being directed to the isolation of carcinogenic fractions from various sources, where large volumes of solvent are involved and the carcinogens are proving to be of a 'weak' nature. Another danger which is worthy of consideration is the possibility of contamination in a syringe being used for injection of a suspected carcinogen, due to inadequate cleaning and examination after use for injection of a potent carcinogen, especially where the syringe has a glass-metal joint and thorough inspection is not possible. We feel in this department that the problem is a serious one, and that the most stringent precautions should be adopted.

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A Variable Phase-Contrast System for Microscopy

Mr. W. G. Hartley[1] has described a variable phase-contrast system for microscopy and considers the possibility of polarizing the diffracted rays and dioptric rays at right angles to one another before introducing a path difference by the use of birefringent material.

Some time ago, an investigation was undertaken into the possibility of developing a phase contrast microscope in which (*a*) the amplitude was variable, (*b*) the phase-difference was variable, and (*c*) in which both were independently variable. This work culminated in the filing of Provisional Application No. 23700/46, and a description of an instrument was read before the Royal Society on March 13 by one of us.

Certain disadvantages result from the premature disclosure of the results of research work undertaken by industry, but it is perhaps as well to state that developments in the direction disclosed by Mr. Hartley have been proceeding for some eighteen months, and that the methods he describes have not been overlooked.

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USE OF RADIOACTIVE ISOTOPES IN IMMUNOLOGICAL INVESTIGATIONS

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SEVERAL methods have been used for the analysis of specific precipitates formed by the union of antigen and antibody and for the determination of the antigen-antibody ratio in these precipitates. Some investigators have used antigens containing a readily determinable element such as iron (hæmoglobin[1]), copper (hæmocyanin[2]), iodine (iodo-albumin[3]) or arsenic[4], or an antigen containing a dye[5]. The precipitates are also usually analysed for protein nitrogen, and Heidelberger and his colleagues have, in particular, developed very accurate quantitative tests for the examination of serological precipitates[6]. N^{15} has also been used in investigations on the formation and the circulation of antibodies and in other immunological studies[7].

During the past year, we have been studying the immunological properties of phosphorylated proteins, and in some of these experiments we have been using radio-phosphorus (P^{32}) as a tracer. It was thought possible that determinations of radio-phosphorus in the specific precipitates might, in conjunction with determinations of total nitrogen, prove very useful in these and similar investigations. Thus in tests with a mixture of two closely related antigens, for example, phosphorylated egg albumin and phosphorylated serum globulin, one antigen containing radio-phosphorus and the other ordinary phosphorus, it should be fairly easy to determine the relative amounts of the two antigens in the specific precipitates by determining the radio and ordinary phosphorus present; in a similar manner, the relative amounts of antigen and 'inhibitory' substances in other serological precipitates might be determined. There are many other ways in which we hope to study the antigen-antibody reaction.

In our investigations with phosphorylated human serum proteins, the immunization of rabbits has yielded antisera containing powerful antibodies against the injected material; but these appear to be directed mainly against the human serum protein configuration. The capacity of these antisera to react with phosphorylated heterologous proteins (for example, phosphorylated rabbit or horse serum proteins) is very weak indeed, and in this respect phosphorylated serum proteins appear to behave somewhat differently from other phosphorylated proteins. Heidelberger, Davis and Treffers[8], for example, readily obtained specific antibody response in rabbits following the injection of phosphorylated egg albumin. At the present time we are studying a possible explanation for these serological differences between the phosphorylated proteins of serum and those of egg albumin, and a full account of these investigations will be given later[9].

Although our antisera are not specific for phosphorylated proteins, they have been useful in some preliminary experiments which we have made to determine whether or not radioactivity determinations can readily be carried out on specific precipitates containing radio-phosphorus. No attempt has been made in these preliminary experiments to purify the antigen (for example, by separating the phosphorylated from the non-phosphorylated proteins) or the antibodies, but this will be done in later experiments. The antigen-antibody mixtures will also be left for several days, to ensure maximum precipitation.

In one experiment, 0·4 ml. of the antiserum was added to 1·0 ml. of antigen solution, and the mixture was kept at 37° for 3 hr. The precipitate was then centrifuged, washed with 0·9 per cent sodium chloride, dissolved in a small volume of 0·1 *N* sodium hydroxide, and the solution dropped evenly on to a layer of kaolin on a brass ring holder and dried. Radio-phosphorus determinations were then made on this precipitate. In other experiments the precipitates were centrifuged and radio-phosphorus determinations were made on these preparations after they had been digested with nitric acid and converted to magnesium ammonium phosphate. The two methods (the 'whole precipitate' and the digestion method) gave essentially the same result, and for most purposes the much quicker method described above is quite satisfactory. Table 1 gives the results of one of these experiments.

TABLE 1. RADIO-PHOSPHORUS CONTENT OF SOME SEROLOGICAL PRECIPITATES

Antigen: Phosphorylated human serum proteins. *Antiserum:* Rabbit antiserum to phosphorylated human serum proteins. *Precipitin tests:* 1·0 ml. antigen plus 0·40 ml. antiserum, kept at 37° for 3 hours

Conc. of antigen (% protein)	Radio-phosphorus in the precipitate (μgm.)
0·83	1·34
0·45	3·5
0·42	4·2
0·22	3·8
0·112	2·4
0·056	1·7
0·028	1·2
0·014	0·5

In other immunological investigations[10] we have been using ovovitellin containing radioactive phosphorus, obtained from the eggs of hens which have received injections of radio-phosphorus (as inorganic phosphate). In these experiments also we have carried out radioactivity determinations on the serological precipitates to determine the amount of antigen in these precipitates. The results of a typical experiment of this type are given in Table 2.

TABLE 2. RADIO-PHOSPHORUS CONTENT OF SEROLOGICAL PRECIPITATES WITH VITELLIN

Antigen: 'Radio'-vitellin (in 10 per cent sodium chloride). *Antiserum:* Antivitellin rabbit serum. *Precipitin tests:* A mixture of 2·0 ml. of antigen, 0·20 ml. of antiserum and 0·20 ml. of 20 per cent sodium chloride, kept at 37° for 3 hours

Conc. of antigen (% vitellin)	Radio-phosphorus in the precipitate	
	(μgm.)	As % of the radio-phosphorus in the antigen used*
2·3	0·0	0
0·37	31·2	19·9
0·13	17·8	34·1
0·042	6·3	36·2
0·014	2·1	36·2
0·0046	0·7	37·6

* The 'radio'-vitellin used in this experiment, though extracted repeatedly with ether, contained appreciable amounts of phosphorus removable by treatment with hot ethanol. The ethanol-extracted vitellin could not be used for these precipitin reactions because of its insolubility. Further investigations are being made to determine whether or not this relatively firmly bound 'lecithin' takes part in the serological reactions with our anti-vitellin sera, and whether, under the conditions of our experiments, 100 per cent of the true protein phosphorus of the antigen can be recovered in the precipitates.

In another experiment we have used an antigen containing radio-sulphur (S^{35}). This antigen was prepared by the action of mustard gas sulphone

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(ββ′-dichlorodiethyl sulphone) containing S^{35} on egg albumin, and precipitin tests were carried out with an antiserum produced in rabbits by the injection of mustard gas sulphone-treated horse serum proteins. Radio-activity determinations on the whole precipitates were made by the method described elsewhere[11], and the results are given in Table 3.

TABLE 3. THE RADIO-SULPHUR CONTENT OF SEROLOGICAL PRECIPITATES
Antigen: Mustard gas sulphone-treated crystalline egg albumin. *Antiserum:* Anti-mustard gas sulphone horse serum proteins. *Precipitin tests:* 0·40 ml. antiserum + 1·0 ml. diluted antigen solution.

Conc. of antigen (% protein)	Radio-sulphur in the precipitate (μgm.)
0·50	15
0·12	12
0·03	0·5

In some of the experiments described above, rather large amounts of antigen solution and antiserum were used, but this was often necessary because of the relatively low specific radioactivity of some of the phosphorus and sulphur available to us. With radioactive elements of greater specific activity, much smaller amounts of antigen and antibody are required, and satisfactory determinations can be made with amounts of these reactants similar to those required for the ordinary micro-precipitin tests. The use of radio-isotopes as tracers in immunochemistry will, we hope, help to throw light on some of the problems which have so far resisted attack by the ordinary methods of quantitative analysis.

For supplies of radio-phosphorus used in these investigations we are greatly indebted to the Medical Research Council and to Prof. J. G. Hamilton of the Radiation Laboratory, California. We are also grateful to Dr. T. E. Banks for his help with the Geiger-Müller counter systems.

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AUTOMATIC REGULATORS AND SERVO MECHANISMS

SOME fifteen main papers and a group of supporting papers dealing with the subject of automatic control systems and servo mechanisms were presented at a convention held at the Institution of Electrical Engineers during May 19–22.

In opening the convention, the Minister of Supply referred to some of the remarkable successes achieved during the War as the result of intensive development of certain specialized servo systems, outlined the fields of applications of these and other related developments in industry generally, and emphasized the importance of utilizing to the full the potentialities of automatic control systems in the national effort to increase production.

Automatic following mechanisms such as those controlling anti-aircraft guns associated with radar, the automatic voltage regulation of electrical generators or the automatic control of temperature or humidity all fall within the general category of servo systems; but a rough general subdivision may be made as between systems concerned primarily with the control of 'position' and those concerned with the regulation of, for example, a chemical process. Although the actual form of a servo system must vary widely from one application to another, there are clearly defined common principles and a fully developed theoretical basis exists. These fundamental considerations were dealt with in three papers under the titles "Fundamental Principles of Automatic Regulators and Servo Mechanisms" by Dr. A. L. Whiteley, "Elements of Position Control" by Prof. K. A. Hayes, and "Theoretical Foundations of Process Control" by Mr. G. H. Farrington. Methods well suited to the development of a systematic and comprehensive theory of servo mechanisms were, as it happened, already available and widely developed within the general field of electrical engineering, particularly the telecommunications branch, when the need arose. Operational methods as applied to the transient response of electrical networks constitute one main means of attack, and feedback amplifier theory employing the Nyquist diagram the other. There is a complete parallel between the problem of avoiding sustained oscillations or 'hunting' in control systems and that of obtaining stability in thermionic amplifiers employing negative feedback.

In part, no doubt, as a result of this, it is found convenient to analyse not only complex electromechanical servos but also complete processes (in chemical engineering, for example) by means of equivalent electrical circuits, the investigation being made either theoretically or experimentally with an actual electrical network involving amplifier valves which will simulate the system or process to be investigated. Such equivalent purely electrical systems were discussed in a paper by Prof. F. C. Williams under the title "Electronic Servo Simulators".

The developments and applications of servos in the Fighting Services during the War were reviewed in a group of papers dealing both with the overall characteristics of the various systems employed in gunnery, the automatic piloting of aircraft, and bomb aiming; and also with the various elements employed in data transmission such as 'Magslips' and 'Selsyns' and the non-electronic power-amplifying units such as magnetic amplifiers or generator amplifiers, that is, amplidynes and metadynes.

In industry, certain forms of automatic control have been employed for many years, as, for example, the voltage control of alternators on power supply systems. Limited application was being made to a variety of industrial problems in the years just prior to the War, and experience was obtained on a greatly increased scale during the War. In a paper dealing with industrial electronic servos, applications in the control of rolling mills, in wire drawing, and in accurate profile machining were described. Two aspects concerned with power-station operation were dealt with in papers on the automatic voltage control of generators and automatic control applied to high-pressure boilers.

Process control was illustrated mainly by examples drawn from the chemical industry. Among the examples given were a controller for the maintenance

of a constant-temperature gradient in a distillation column, liquid-level regulators, and a system for the control of salt concentration in an evaporator.

An entirely different but fundamentally important aspect of control systems which involve the services of an operator was discussed by Prof. A. Tustin in a paper entitled "The Nature of the Operator's Response in Manual Control". The operator's response is found to be non-linear and subject to a time delay corresponding to that known to be involved in nerve impulse transmission. A further contribution dealing with the physiological implications of the manual tracking research conducted during the War was made in a paper by Dr. J. A. V. Bates entitled "The Design and Performance of the Human Servo".

At each session of the convention a period was set aside for the discussion of the papers presented. It was noteworthy that despite efforts at standardization of terminology, there are already firmly established differences in nomenclature between process control and the other branches of servo work. The relative reliability of hydraulic and pneumatic systems in relation to electronic systems was a matter which evoked considerable discussion and, in the same connexion, the 'life' of electronic apparatus in control systems generally. The effects of backlash and non-linearity were also discussed.

In a concluding address reviewing the convention, the president of the Institution of Electrical Engineers, Mr. V. Z. de Ferranti, outlined the ground covered by the various contributions and indicated those directions in which he considers the developments of automatic control systems could be turned to good account in meeting the challenge now presented to the whole industrial organisation of Great Britain.

J. GREIG

SCIENTIFIC RESEARCH AND INDUSTRIAL DEVELOPMENT IN SCOTLAND

AT the regional conference on "Research and the Progress of Industry in Scotland", organised by the Federation of British Industries in Glasgow last April, the tendency for the direction of policy, market research and technical research to become concentrated in the south-eastern portion of the United Kingdom even although production might be located where labour was available, sometimes at considerable distances from headquarters, came in for some criticism. Dr. W. M. Cummings, for example, remarked that practically all the research associations sponsored by the Department of Scientific and Industrial Research are situated in that area, and suggested that this may be one reason why Scottish industry has not utilized such research organisations more fully. Dr. Cummings himself urged that the technical colleges might make a greater contribution towards industrial research in Scotland, and pointed to the Joint Research Council established in Manchester as a pattern that might be followed in other industrial areas. From Prof. R. Hay, also of the Royal Technical College, Glasgow, came the further suggestion for a Scottish industrial research institution on the lines of the Mellon Institute; and some dissatisfaction with the present situation also pervades Dr. Wightman's review of the work of Scottish research institutions issued under the title "Science in Scotland".

What characterizes these criticisms of the present position is, however, the constructive proposals to which they lead, and the evidence of a disposition to explore new methods of dealing with the special situation in Scotland. The need for some definite industrial policy for Scotland is, moreover, the dominant impression left by the report on Industry and Employment in Scotland which has since been issued by the Scottish Office*. The report, indeed, contains remarkable evidence of the energetic way in which local men have tackled Scotland's economic difficulties. In 1933, some 30 per cent of the insured population of Scotland were unemployed, and in July 1939 there were still 10·5 per cent unemployed. The figure for February 1947 was about 6 per cent, the number of unemployed being less than half the corresponding figure for July 1939, and the one and a half million workers were responsible in 1946 for 12·5 per cent of the British output of coal, 38 per cent of the output of new ships, 13·9 per cent of the output of steel ingots and metals for castings, 40 per cent of the output of builder's castings, 45 per cent of the output of locomotives constructed by private builders, 16 per cent of the output of railway wagons, 50 per cent of the output of steam-raising plant and 25 per cent of the output of coalmining machinery.

The importance of these products in the present economic position is obvious; and in addition, the whole of the British output of jute, 90 per cent of its sewing machines, 75 per cent of its oat products, 66 per cent of its kippers and pickled herrings, and 33 per cent of its carpets and of its smoked white fish are provided by Scottish workers. Moreover, there is no general serious shortage of man-power in Scotland, although man-power problems exist in such industries as coal-mining, iron foundries and agriculture. The general picture is one of a very high level of employment, with considerable differences in the level in different industries and districts, shortages of labour in some basic industries, and, on the other hand, some difficult problems of employment, particularly among men and in the outlying areas. This special problem lies mainly in the Development Area, but there are special problems in the Highlands and the islands.

For the rest, the economic problems confronting Scotland are those common to the United Kingdom as a whole, and vigorous measures are being taken to man and develop the basic industries. Scottish engineering is being strengthened and diversified by the introduction of new lines of production as a result both of the War and the Government's policy for the distribution of industry. To provide a fuller diversification of Scottish industry and greater opportunities for employment, the Government, states the report, is attempting to accelerate the building of the new factories already planned and to attract to Scotland, and especially to the Development Area, further industries of the right type, particularly medium engineering, furniture and similar firms which will employ men without at the same time demanding an exceptional degree of physical fitness and strength.

The fourth part of this report, covering technical education and industrial research, as well as general labour questions, is, however, that of main interest to scientific men. The survey of technical education

* Industry and Employment in Scotland. (Cmd. 7125), (Edinburgh and London: H.M. Stationery Office, 1947.) 2s. net.

once again emphasizes that Scotland's basic need is a great increase in the number of local technical colleges, and large and important sections of Scottish industry are ready to take advantage of such provision. Moreover, the demand is not for narrower vocational education but for a type of education which will produce not only a well-trained worker but also an intelligent and responsible worker and citizen. There is also a new attitude towards day release in much of industry; but while many education authorities are ready to meet or encourage demands from industry, the lack of technical colleges or other suitable accommodation restricts their efforts. Again, while it is hoped to announce at an early date the establishment of five regional advisory councils for technical education, based on Aberdeen, Dundee, Edinburgh, Glasgow and Inverness, developments in the central institutions such as the Royal Technical College, Glasgow, have had to be postponed. Production engineering is cited as an example; but, on the other hand, arrangements for the training of industrial designers, including close co-operation with industry, are being discussed with the Scottish Committee of the Council of Industrial Design in relation both to art colleges and to technical colleges. The Scottish Woollen Technical College, with the active co-operation of the Scottish woollen manufacturers, is developing a new broad type of practical training for mill-workers, and at the same time planning developments in higher textile education and research. There has, however, been a marked lack of development in training for management. Scottish industry has not responded well to efforts which the central institutions have made to assist in the training of foremen, and there has been virtually no demand for higher forms of training in management.

An ambitious scheme for industrial research put forward by the Royal Technical College, with the object of establishing the right atmosphere for a first-grade teaching institution and to give Scottish industry all possible assistance in facing its research problem, has recently been approved. Generally, it is observed that while some Scottish firms have admirable laboratories, the volume of industrial research in Scotland is proportionately much less than in certain areas of England, and in spite of the fact that the output of science graduates from Scottish universities is higher in proportion to the population than that of English universities, the report quotes from a survey conducted by the Federation of British Industries which indicates that approximately thirty research workers of graduate standard are employed in England and Wales for one in Scotland, a discrepancy of four to one, after taking into account the population ratio. Many of the industries which give employment to scientific workers are relatively undeveloped in Scotland, and the lack of research workers tends to perpetuate this position. While there are Scottish industries which illustrate the healthy growth produced by a reasonable investment in research, it can be argued that the relative weakness of industrial research in Scotland has militated against the growth of fresh enterprise and the creation of employment in new industries.

The survey suggests that the volume and variety of industrial research in Scotland are not sufficient to ensure healthy industrial development, and that Scottish manufacturers must be encouraged and helped to make the most of the facilities available to them for the application of scientific knowledge in their industries. In commenting on the work of the Department of Scientific and Industrial Research, both from the point of view of its present research activities in Scotland and the assistance which the Department might give to Scottish industry, the report suggests that the advisory services to be rendered to industry might be given more weight in determining the location of the Department's laboratories. The effectiveness of the assistance given by the laboratory to a firm may be diminished if the laboratory is remote from the firm. Both the framing of the research programme and the utilization of its results depend for efficiency largely on personal contacts. The new office of the Department which has now been opened in Edinburgh should do much to assist Scottish industry in drawing upon the resources of the existing Government facilities for research, and will be in a position to make a realistic assessment of needs for which provision may not at present be made. Among the functions of the new office, for example, are the study of the Scottish industrial position with the view of assisting in the formulation of problems suitable for research, and the examination of the need for additional research facilities as well as for the application of existing facilities as effectively as possible. It will also help to make more readily available in Scotland the large volume of scientific information which exists within the Department; and the office will also take appropriate steps to ensure that discoveries in pure science which may be capable of industrial application are not overlooked, and that opportunities for new developments are not missed.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS, 1947

THE fifty-second annual congress of the South-Eastern Union of Scientific Societies was held at Brighton during July 14–19 at the invitation of the Mayor of Brighton and with the co-operation of the Brighton and Hove Archæological and Natural History Societies.

The Mayor welcomed the members at the Royal Pavilion, which had been placed at their disposal by the Corporation, and also entertained them at a conversazione where special demonstrations were given on subjects of scientific interest. The Congress Museum was accommodated in the King's Apartments where, throughout the week, an exhibition of drawings and photographs of all the British orchids was displayed by E. J. Bedford. There was also a display of local wild flowers arranged by the Brighton Students Association.

In addition to the public evening meeting, a film display for school children was given in the Pavilion Theatre. The films, which had been prepared by the Central Office of Information for the Ministry of Education, to be used in schools, pointed out the significance of the rocks, antiquities, flora and fauna in our history and economy. Dramatization had rightly been avoided in the preparation, but some processes were demonstrated.

Prof. W. A. F. Balfour-Browne, in delivering his presidential address on "The Possibilities of Natural History", said that, for his purpose, natural history

would be considered as an amateur's study of natural objects and the possibilities arising therefrom. In some cases interest arises from the stimulus of a book or a museum visit, in others from the acquisitive habit, the formation of a collection being the first interest of a young naturalist. Recognition of specimens from book illustrations is a method that gets nowhere, and a genuine naturalist must become acquainted with structural characters and environment. Prof. Balfour-Browne illustrated his general principles by examples from insect life. Dealing mainly with the water beetles, he spoke on district localization, habitat localization, life-histories and structural characters, including surface sculpture, tarsal claws, sucker hairs and post coxæ. He said that the question arises of what facts mean, and the interpretation of facts is often open to criticism. The processes of evolution were described, and it was remarked that the phenomenon of 'orthogenesis' is recognized by palæontologists but not by most biologists, although recently there has been talk of 'trends', so it may be that orthogenesis will be accepted as a process by which species originate. In conclusion, Prof. Balfour-Browne advised the amateur to observe and note everything, even the trivial, but to be careful in interpretation.

The Archæological Section was addressed by its President, J. E. Ray, on "Sussex and Normandy in Norman Times". He pointed out that the inlets along the coast afford an easy basis for penetration into the hinterland, and that, in all ages, Sussex has been the subject of both friendly and hostile penetrations from the sea. These produced a Continental influence on Sussex architecture and a return Sussex influence on the Continent, particularly in Normandy.

Dr. A. E. Wilson read a paper on "Some Archæological Problems in South-East England".

The Section's excursion to Cissbury to examine the Early Iron Age hill-fort and Neolithic flint mines was conducted by Dr. E. Cecil Curwen, and a general excursion to Lewes was arranged by I. D. Margary.

The presidential address to the Botanical Section was given by E. J. Bedford on "Some Orchids of Kent and Sussex". It was illustrated by many excellent lantern slides prepared by Mr. Bedford, who has photographed nearly all the British orchids *in situ*, having exposed more than three thousand plates in the process.

A paper on "The Ecology of Ditchling Common" was prepared by P. J. Wanstall. The leaders of the excursion to the Common were D. H. Phillips and P. Austwick, and a joint excursion to Lewes Levels with the Zoological Section was arranged.

The president of the Geological Section, A. H. Toms, gave an address on "Soil in Civil Engineering". He dealt with the physical characteristics of granular and cohesive soils as affecting the engineer, and described the methods of obtaining undisturbed samples, tests for particle-size distribution, consolidation under pressure, plastic limit, liquid limit, compressive and shear strengths. These characteristics were related to the settlement of buildings, shear failure of footings, landslides, the design of roads and runways and formation problems on railways. Reference was also made to such expedients as ground-water lowering, ground freezing, chemical consolidation and electro-osmosis.

F. Needham Green gave a paper on "Local Geology as affecting the Water Supply of Brighton", and conducted an excursion to the pumping stations and waterworks of the Corporation. An excursion to Offham to examine the fossiliferous chalk of the zone of *Micraster cortestudinarium* was conducted by C. T. A. Gaster.

Prof. G. D. Hale Carpenter, president of the Zoological Section, addressed the members on "Protective Coloration in Insects, and its Interpretation". The subject was treated as a general survey showing how all the varied protective devices can be interpreted by the Darwin–Wallace theory of natural selection. The first way of escaping enemies is to be physically invisible by concealment. Next there is physiological invisibility, 'crypsis'—the insect is there to be seen but cannot be perceived. Another method, 'allo-crypsis', consists of utilization of part of the actual surroundings to conceal the insect. Prof. Hale Carpenter then dealt with 'warning colours' (aposematic methods), saying that the habits were adapted for free display. Finally, he dealt with mimicry (pseudaposematic methods), stating that no explanation copes with the facts so well as natural selection.

Dr. W. Norman Maple gave a lantern lecture on "The Dinosaurs", and S. J. Teideman read a paper on "Some Interesting Birds of Pagham Harbour".

A tour of the Booth Museum with its unique collections of birds and Lepidoptera was conducted by Major H. Blackiston, an excursion to Heathfield by H. F. Brazenor, and a visit to the gardens of Highdown Towers and the camp on Highdown Hill was arranged by Dr. A. E. Wilson.

After the business meeting of the general assembly, a discussion on "The Place of Scientific Societies in the Promotion of Science" was opened by Dr. J. Ramsbottom. His remarks were based upon a recent circular letter of the British Association, and he dealt with the collection of information, dissemination and discussion, research and organisation. After stressing the importance of the observations of amateurs to the professional man of science, Dr. Ramsbottom said that, with the increasing leisure of the working people, facilities should be provided to enable the extension of knowledge of the natural sciences, thereby assisting the scientific workers in research and benefiting the community as a whole. At the conclusion of the discussion, D. N. Lowe, secretary of the British Association, thanked the delegates for the consideration given to the question.

The next Congress of the Union will be held at Great Yarmouth during June, 1948.

FORTHCOMING EVENTS

Thursday, September 11—Friday, September 12

INSTITUTE OF WELDING (in the Addison Restaurant, Olympia, London, W.).—Autumn Meeting.

Thursday, September 11

At 2.30 p.m.—Mr. H. E. Lardge: "Welding in the Development of Jet Propulsion Engines"; at 5 p.m.—Mr. E. C. Davies: "Some Novel Developments in the Design and Operation of A.C. Arc Welding Plant".

Friday, September 12

At 2.30 p.m.—Mr. A. H. Bent: "Stud Welding Development and Application"; at 5 p.m.—Mr. J. K. Johannesen: "Some Aspects of Welding Repairs".

Thursday, September 11—Saturday, September 13

BRITISH RHEOLOGISTS' CLUB (at Hulme Hall, Victoria Park, Manchester).—Annual Conference.

Saturday, September 13—Sunday, October 5

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, London, S.W.7).—Ninety-second Annual Exhibition. Part 1: Pictorial and Colour.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

JUNIOR PHYSICIST for work on the application of high energy radiations to biological and medical research—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12 (September 12).

LABORATORY ASSISTANT (Grade II) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 13).

TECHNICAL LIAISON OFFICER for the London Offices—The International Wool Secretariat, 18–20 Regent Street, London, W.1 (September 13).

ASSISTANT LECTURER IN PHYSICS in the Bradford Technical College—The Director of Education, Town Hall, Bradford (September 13).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 13).

SENIOR ASSISTANT IN THE MECHANICAL ENGINEERING DEPARTMENT of the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (September 13).

GENERAL SECRETARY—The Honorary Secretaries, Chemical Society, Burlington House, Piccadilly, London, W.1 (September 15).

LECTURER (Grade IIa) IN NEURO-PHYSIOLOGY, a LECTURER (Grade IIc) IN EXPERIMENTAL PHYSIOLOGY, and an ASSISTANT LECTURER (Grade IIc) IN HISTOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (September 15).

ASSISTANT LECTURERS (2) and DEMONSTRATORS (3) IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, University College of South Wales, Cathays Park, Cardiff (September 20).

LECTURER or ASSISTANT LECTURER (man) IN COLONIAL SOCIAL SCIENCE—The Secretary, London School of Economics, Houghton Street, London, W.C.2 (September 21).

LECTURER (Grade IIc) IN ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (September 22).

SENIOR RESEARCH OFFICER IN IMMUNO-GENETICS at the Animal Research Station, Ruakura—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 27).

INFORMATION OFFICER AND LIBRARIAN IN THE DEPARTMENT OF GLASS TECHNOLOGY—The Registrar, The University, Sheffield (September 27).

EDUCATION PSYCHOLOGIST (female)—The Town Clerk, Guildhall, Nottingham (September 27).

LECTURER IN BIOCHEMISTRY—The Secretary of University Court, The University, Glasgow (September 30).

MECHANICAL ENGINEERS (temporary) at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—Post C.474/47A, PRINCIPAL MECHANICAL ENGINEER (with not less than 10 years of practical engineering work); Post C.476/47A, MECHANICAL ENGINEER (with not less than 5 years practical experience); Post C.475/47A, DESIGN ENGINEER (with not less than 3 years experience)—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 30).

CHIEF HORTICULTURAL OFFICER for the Imperial War Graves Commission in United Kingdom—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2 (September 30).

TECHNICAL PHOTOGRAPHER in the Chester Beatty Research Institute—The Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (October 1).

ASSISTANT LECTURER IN PHYSICS—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 1).

COKE RESEARCH FELLOWSHIP tenable in the Department of Coal Gas and Fuel Industries—The Registrar, The University, Leeds 2 (October 1).

UNIVERSITY DEMONSTRATOR IN THE DEPARTMENT OF MINERALOGY AND PETROLOGY—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Downing Place, Cambridge (October 1).

REGISTRAR—The Secretary to Council, Westfield College, London, N.W.3 (October 1).

UNIVERSITY LECTURER and a UNIVERSITY DEMONSTRATOR IN THE DEPARTMENT OF CHEMICAL ENGINEERING—The Shell Professor of Chemical Engineering, King's College, Cambridge (October 6).

CHEMISTS for appointments in the CHEMICAL RESEARCH LABORATORY, Teddington, for work on materials of interest in relation to atomic energy: (*a*) one experienced and well qualified INORGANIC CHEMIST with knowledge of modern physical methods, (*b*) one PHYSICAL CHEMIST or CHEMICAL ENGINEER, preferably with a knowledge of extraction processes, (*c*) two CHEMISTS to undertake research on methods of chemical analysis of inorganic materials; EXPERIMENTAL or ASSISTANT EXPERIMENTAL OFFICERS: (*d*) two for development work with experience of semi-scale operations, (*e*) others for analytical work by both chemical and physical methods and to assist in research into new methods—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.700/47A (October 11).

CHAIR IN MATHEMATICS—The Registrar, University College, Leicester (October 18).

TECHNICAL ASSISTANTS (Grade II) IN THE DEPARTMENT OF PATHOLOGY (including Bacteriology), University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 31).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, University College of South Wales, Cathays Park, Cardiff (November 3).

CHAIR OF ELECTRICAL ENGINEERING in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 10).

ELECTROCARDIOGRAPHIC TECHNICIAN, and a LABORATORY TECHNOLOGIST (Grade B)—The House Governor, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks.

SOIL SURVEY OFFICER—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHIEF LABORATORY TECHNICIAN (Grade A) at Oldchurch Cou... Hospital, Romford—The Clerk of the County Council, County Ha... Chelmsford.

LECTURER IN ELECTRICAL ENGINEERING AND ENGINEERING SCIE...—The Principal, Technical Institute, Midland Road, Bedford.

LECTURER IN CHEMISTRY—The Principal, Technical College, Ches... Street, Barnsley.

LECTURERS (part-time, evening) IN (*a*) PURE AND APPLIED MATH... MATICS to Intermediate and B.Sc. (General) standard; (*b*) PHYS... to B.Sc. (General) and B.Sc. (Special) standard—The Clerk to th... Governors, Northern Polytechnic, Holloway Road, London, N.7.

HEAD OF THE CHEMICAL ENGINEERING DEPARTMENT, a LECTUR... IN MECHANICAL AND CIVIL ENGINEERING, and a LECTURER I... MATHEMATICS AND PHYSICS, Treforest School of Mines and Technolo... Pontypridd—The Director of Education, County Hall, Cardiff.

AGRICULTURAL CHEMIST (Pyrethrum) by the Government of Ken... —The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.M.17954.

LECTURER IN PHYSIOLOGY AND ZOOLOGY—The Registrar, Techn... College, Sunderland.

BIOCHEMIST or ORGANIC CHEMIST for a research appointment i... the Courtauld Institute of Biochemistry—The Medical Scho... Secretary, Middlesex Hospital, London, W.1.

SENIOR ASSISTANT IN CHEMICAL ENGINEERING—The Registra... Loughborough College, Loughborough, Leics.

ASSISTANT SCIENTIFIC INSTRUMENT MAKER—The Superintende... Christie Hospital and Holt Radium Institute, Manchester 20.

MEDICAL LABORATORY TECHNICIAN to work in the Biochem... Department—The Secretary-Superintendent, Royal Salop Infirmary, Shrewsbury.

TECHNICIAN for training in freeze-drying methods—The Direct... Lister Institute, Chelsea Bridge Road, London, S.W.1.

PHYSICAL CHEMIST—The Secretary, British Rubber Produce... Research Association, 19 Fenchurch Street, London, E.C.3.

BIOLOGICAL ASSISTANT, holding a B.Sc. in Physiology or Zoolo... Mrs. Simpson, Courtauld Institute, Middlesex Hospital, London, W.1.

HOROLOGICAL CRAFT SPECIALIST—The Secretary, National Coll... of Horology, Northampton Polytechnic, St. John Street, Lond... E.C.1.

LECTURERS IN GEOGRAPHY, MATHEMATICS, BOTANY, and HISTO... in the Education Department, Nigeria—The Director of Recruitme... Colonial Service, 15 Victoria Street, London, S.W.1.

ASSISTANT FORESTER with the Forestry Department, Tasmani... The Agent-General for Tasmania, Golden Cross House, Charl... Cross, London, W.C.2.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

Industrial Film Service. Pp. 14. (Leatherhead: Blackheath Fi... Unit, Ltd., 1947.)

Ministry of Fuel and Power. Twenty-fourth Annual Report of ... Safety in Mines Research Board, 1945. Pp. 40. (London: H.... Stationery Office, 1947.) 1*s.* net.

Reports on Fuel Economy since 1939. French National Committ... Pp. 28. 1*s.* 6*d.* Irish Committee. Pp. 8. 6*d.* net. (London: W... Power Conference, 1946.)

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British Standard 1347:1947. Architects', Engineers' and Su... veyors' Boxwood Scales. Pp. 16. (London: British Standards Insti... tion, 1947.) 2*s.* net.

Other Countries

League of Nations: Economic, Financial and Transit Departme... The Cause and Control of Inflation: a Review of Monetary Experie... in Europe after World War I. (Series of League of Nations Publicatio... II. Economic and Financial, 1946. II. A.6.) Pp. v + 136. (Gene... League of Nations; London: George Allen and Unwin, Ltd., 194... 5*s.* net.

Food and Agriculture Organization of the United Nations. Fores... and Forest Products: World Situation 1937–1946. Pp. 94. Report... the Second Session of the Conference held at Copenhagen, Denmar... 2–13 September 1946. Pp. xvii + 70. (Washington, D.C.: Food a... Agriculture Organization of the United Nations, 1946.)

Smithsonian Institution: Freer Gallery of Art. Occasional Pape... Vol. 1, No. 1: The Grand Empress Dowager Wên Ming and ... Northern Wei Necropolis at Fang Shan. By A. G. Wenley. (Publi... tion 3861.) Pp. iii + 28 + 7 plates. (Washington, D.C.: Smithsonia... Institution, 1947.)

South Australia: Institute of Medical and Veterinary Scien... Eighth Annual Report of the Council, July 1945–June 1946. Pp. ... (Adelaide: Institute of Medical and Veterinary Science, 1946.)

Proceedings of the American Philosophical Society. Vol. 91, No. ... February 25, 1947: America's Role in the Growth of Science, Presi... Trends and International Implications of Science, Problems of Int... national Cooperation in Science, and the Pilgrim Trust Lectu... Papers read before the American Philosophical Society and the Natio... Academy of Sciences, October 17–23, 1946. Pp. iii + 136. (Philad... phia: American Philosophical Society, 1947.)

All-Electronic Color Television created by RCA. Statements ... Brig.-General David Sarnoff, Dr. C. B. Jolliffe and Niles Tramm... Pp. 18. (New York: Radio Corporation of America, 1946.)

Gold Coast Colony. Report on the Forest Department for the Ye... 1945–46. Pp. 8. (Accra: Government Printing Department; Londo... Crown Agents for the Colonies, 1946.) 1*s.*

Bulletin of the American Museum of Natural History. Vol. ... Article 1: The Monotremes and the Palimpsest Theory. By Willia... King Gregory. Pp. 52 + 2 plates. (New York: American Museum ... Natural History, 1947.)